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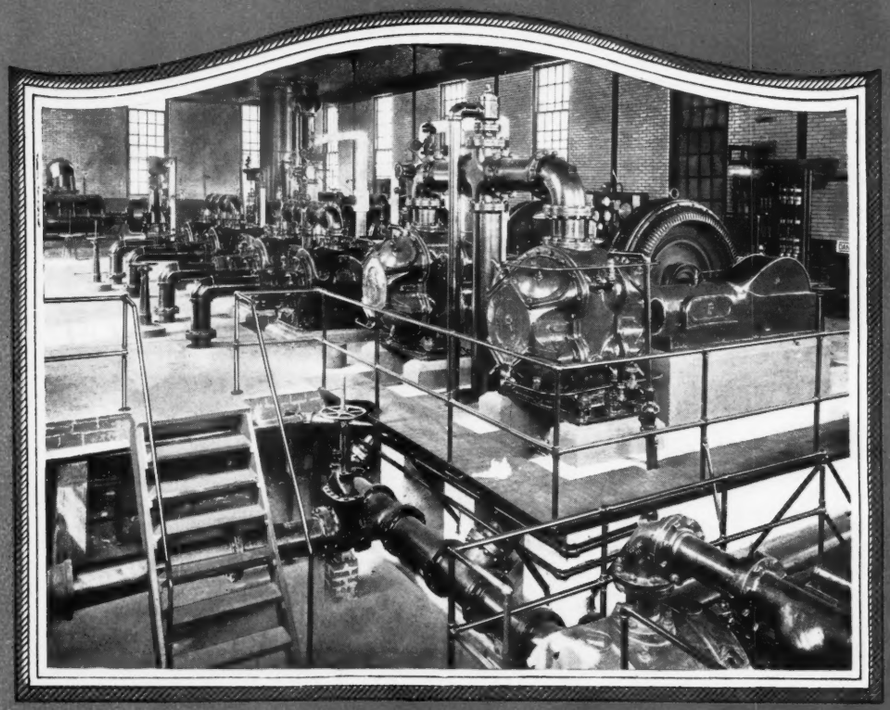

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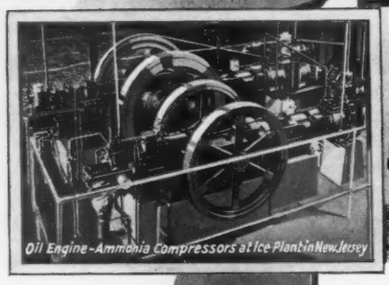
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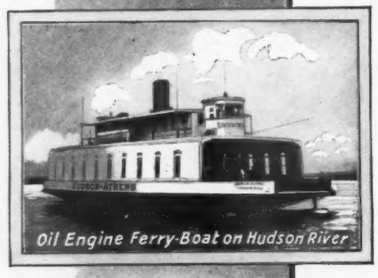
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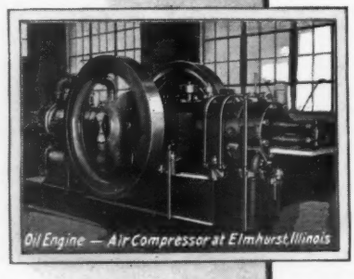
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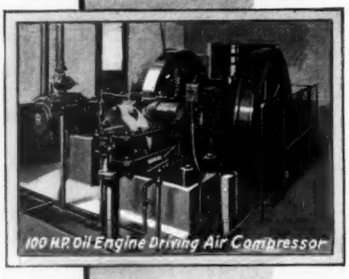
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Modernizing A Water Works by the Adoption of Oil-Engine Drive For Air Compressors

By CHARLES A. NILES*

SATISFACTORY water service is becoming an increasingly urgent problem with numerous communities that have emerged latterly from the village type and have assumed associate responsibilities for the general good and the promotion of local industrial and business life.

The outstanding need, apart from the paramount one of an untainted source of supply, is the providing of sufficient water at the lowest practicable cost consistent with efficient service. The story about to be told recites the experience of Freehold, N. J., an industrious and interesting borough having a resident population of about 6,000 persons.

How Freehold has recently modernized its water works offers an object lesson which may be helpful to other communities still employing steam equipment, as did Freehold before her wide-awake authorities saw the wisdom of changing over to oil-engine drive.

FREEHOLD, N. J., the county seat of Monmouth County and the center of a rich agricultural district, changed over in 1919 from the old town of 1869 and became an incorporated borough. Such a right about face in municipal government naturally brought forward a number of new problems—one of the more serious of these being that of modernizing the community water works. The established plant had grown from a small beginning, and had, as is so often the case, gradually lost ground until it was neither adequate for the needs of the borough nor profitable to operate.

The pumping station is located some two miles from town, and as originally built obtained its water from eight 3-inch Artesian wells which were sunk through 40 feet of marl into a water-bearing stratum ranging from 8 to 10 feet in depth. In the old days, the water gushed from 6 to 8 feet above the surface of the ground and was conducted to a small cistern from which it was delivered by steam pumps, through a 10-inch main, to the town distributing system. All surplus water was raised to a standpipe, 20 feet in diameter and 100 feet high, situated about half a mile from the pumping station. The water works was established in 1890.

With the increasing requirements of the town, greater demands were put on the underground storage, and this continued until the water ceased to flow to the surface. Then a small air compressor was installed for air-lift service. This answered for a time; but after a while the demands caught up with the supply and new 8-inch wells were driven. These were equipped with coarse screens, and were carried down beyond the water-bearing stratum to a total depth of 100 feet so as to insure greater submergence for the air and the discharge pipes.

In this manner the plant expanded until by 1920 the equipment consisted of three 50-H.P. boilers—supplying steam for two air compressors having a total capacity of from 400 to 450 cubic feet of free air per minute at a pressure of 30 pounds—and of two duplex steam pumps, respectively, of 750,000 and 1,000,000 gallons capacity, pumping into the standpipe without filtration. The water was taken from ten 8-inch wells each 100 feet deep.

Water and sewer mains were rapidly extended into the new territory annexed when the old town became a borough; and when the industrial demands of a large factory, lima-bean and tomato canning plants, and several smaller factories, together with the need of increased fire protection, were considered, it was found that the water situation was in an acute stage.

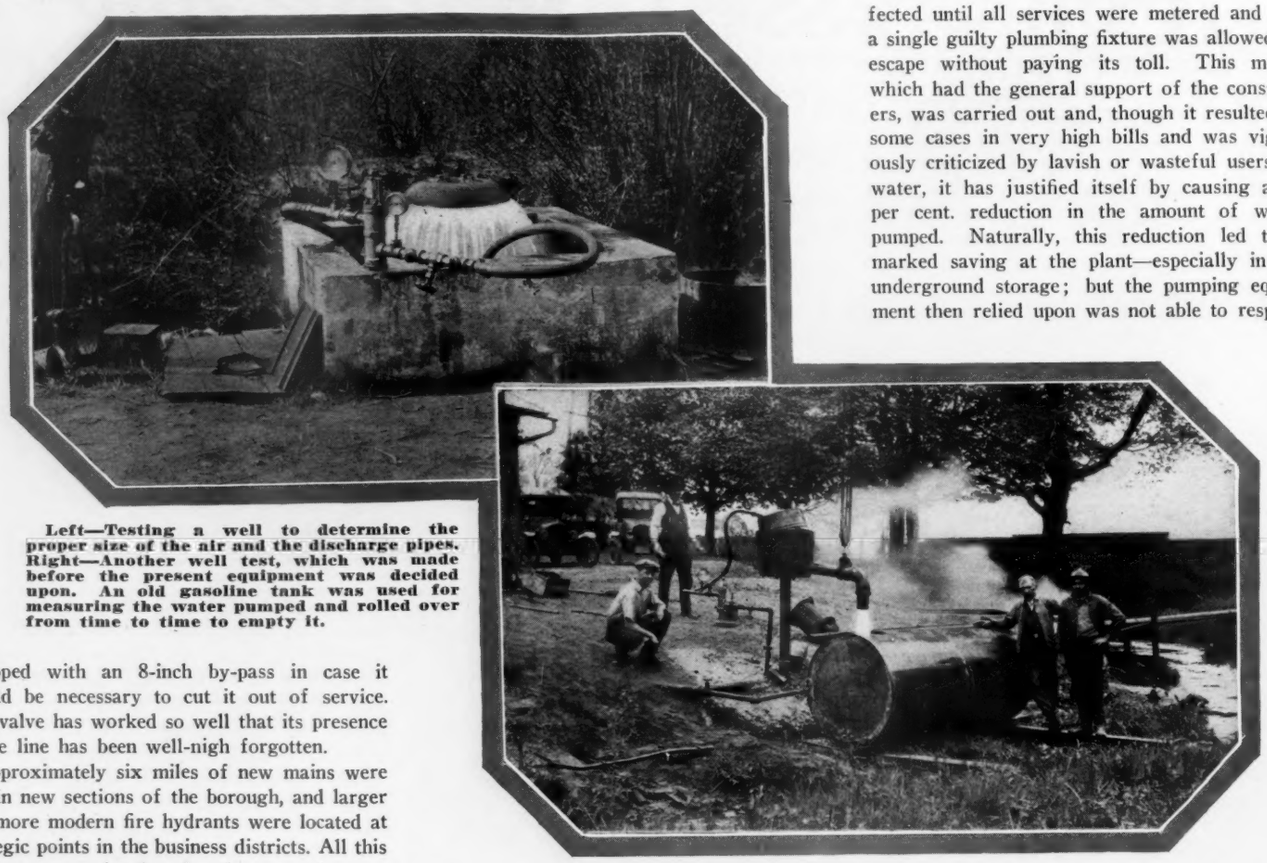
At this point, it was felt that the problem should be attacked from three angles, namely: first, by providing additional storage capacity with more mains and hydrants for proper fire protection; second, by amplifying the water supply through the driving of new wells—possibly to another stratum, or by checking unwarranted and wasteful use of water by the adoption of meters; and, third, by effecting a reduction in the operating costs at the pumping station. The price of coal, the charges for cartage, the bill for labor, and the outlay for repairs kept mounting year after year. Therefore, the three contemplated steps were taken; and now, after a fair trial, the wisdom of this course has been convincingly demonstrated.

A new 12-inch, cast-iron main was laid from the pumping station to well within the limits of the existing distributing system and connected to the smaller mains at intersecting points. As far as practicable, the large main was run over a separate route from that followed by the old 10-inch main in order to avoid any interruption of service in either of the lines by serious damage to the other one. At one common point the two supply mains were cross connected by means of suitable valves so that sections of both mains could be used in case of partial failure of either line.

A new 200,000-gallon tank, set on a 6-post steel tower, was located on high ground along the line of the new 12-inch main and placed so that the elevation at the top of the tank would be 10 feet above the top of the old standpipe. The tank and the supporting tower were constructed by the Pittsburgh-Des Moines Steel Company. The new tank increased the town pressure from 42 to substantially 47 pounds; and this, with the augmented water storage, was welcomed especially by the fire department.

As both lines and both the standpipe and the tank are normally in service simultaneously, a Golden-Anderson altitude valve was put in the feeder to the standpipe. This valve was interposed between two 10-inch valves and

*Superintendent of Public Works, Freehold, N. J.

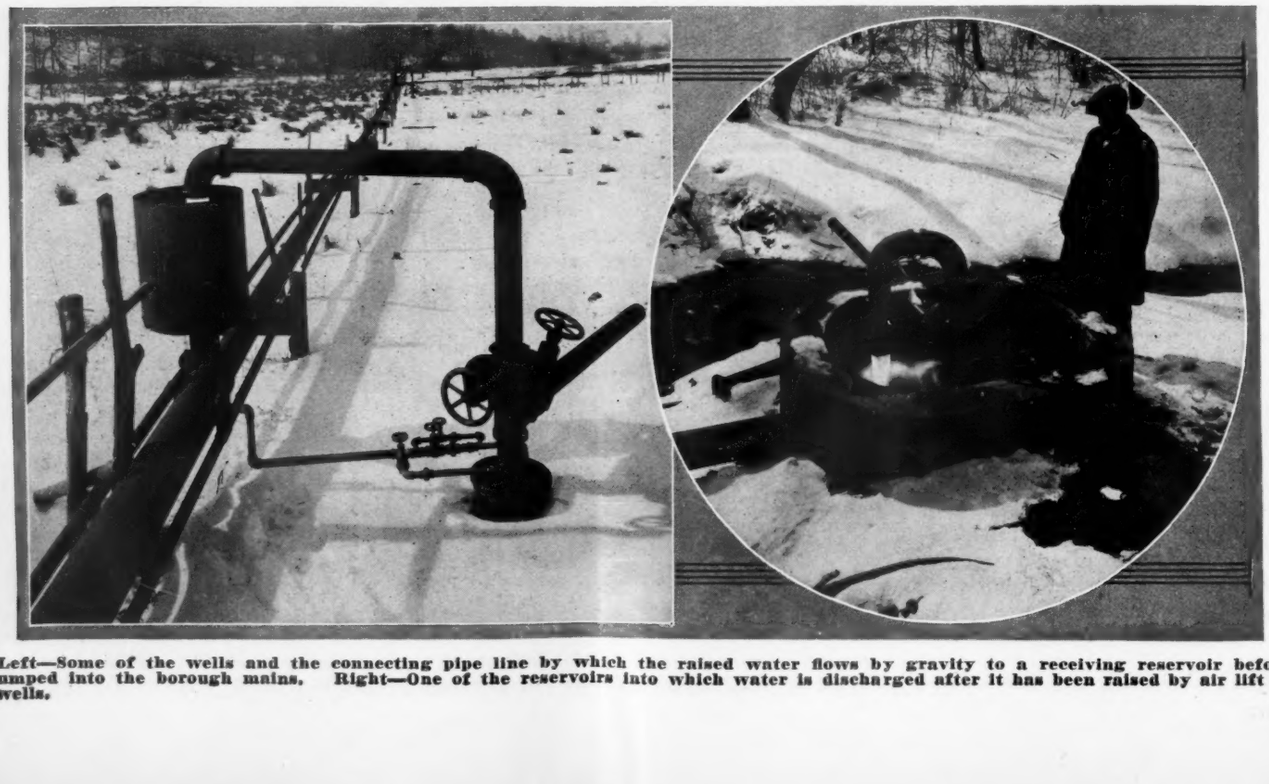


Left—Testing a well to determine the proper size of the air and the discharge pipes. Right—Another well test, which was made before the present equipment was decided upon. An old gasoline tank was used for measuring the water pumped and rolled over from time to time to empty it.

equipped with an 8-inch by-pass in case it should be necessary to cut it out of service. The valve has worked so well that its presence in the line has been well-nigh forgotten.

Approximately six miles of new mains were laid in new sections of the borough, and larger and more modern fire hydrants were located at strategic points in the business districts. All this work was completed under the general supervision of the borough officials, and was in accordance with original plans prepared by Messrs. Waring, Chapman & Farquhar, consulting engineers, who have acted in an advisory capacity for Freehold during the past 30 years.

With the foregoing provisions made, the next questions to be settled were those having to do with conserving the water supply and with cutting down the cost of pumping. Water meters had been placed some years previously on the premises of all large consumers; but it was realized that no substantial saving could be effected until all services were metered and not a single guilty plumbing fixture was allowed to escape without paying its toll. This move, which had the general support of the consumers, was carried out and, though it resulted in some cases in very high bills and was vigorously criticized by lavish or wasteful users of water, it has justified itself by causing a 45 per cent. reduction in the amount of water pumped. Naturally, this reduction led to a marked saving at the plant—especially in the underground storage; but the pumping equipment then relied upon was not able to respond in proportion. The high overhead incident to operating inefficient machinery had still to be contended with; and the success of the meter plan, due to its decrease in revenue production, necessitated a thorough modernizing of the pumping machinery.



Left—Some of the wells and the connecting pipe line by which the raised water flows by gravity to a receiving reservoir before it is pumped into the borough mains. Right—One of the reservoirs into which water is discharged after it has been raised by air lift from the wells.

As a matter of fact, this work was taken in hand while the meters were being installed. A preliminary step called for an investigation of the existing wells to determine the type of equipment most suitable—whether new and larger wells with deep well pump heads should be resorted to, or if turbine pumps or a continuation of the air-lift system should be relied upon.

The relative merits of various schemes for operating the wells were thoroughly analyzed; but, in the light of the experience of Mr. W. A.

No. of Run	Time	Starting Pressure Lbs.	Shut-in Pressure Lbs.	Working Pressure Lbs.	Air Cu. Ft. per Min.	Water Gals. per Min.	Cu. Ft. Air per Gal. Water	Remarks
1	9.56	27	21	24.5	43.8	78	.562	Ten wells on.
2	10.13		20.5	25.2	46.7	81.15	.578	Receiver pressure 30 lbs.
3	10.39			24.2	29.0	55.5	.535	Well started at 6 a. m.
4	10.52		20.5	24.3	37.8	66.7	.570	
5	11.02			24.8	44.7	77.0	.580	
6	11.12		19.0	27.8	67.6	103.0	.655	Receiver pressure 37 lbs.
7	11.19			24.9	51.3	85.1	.602	
8	11.37			23.8	43.5	80.8	.548	Five wells on.
9	11.51			27.2	68.5	85.1	.780	
10	1.34		16.5	25.5	56.9	76.17	.748	Receiver pressure 30 lbs.
11	1.41	26	19.0	24.86	51.0	74.9	.680	Eight wells on.
12	1.49			24.30	45.8	67.0	.684	
13	1.55			25.02	50.0	69.0	.724	
14	2.04			25.2	50.4	67.0	.750	

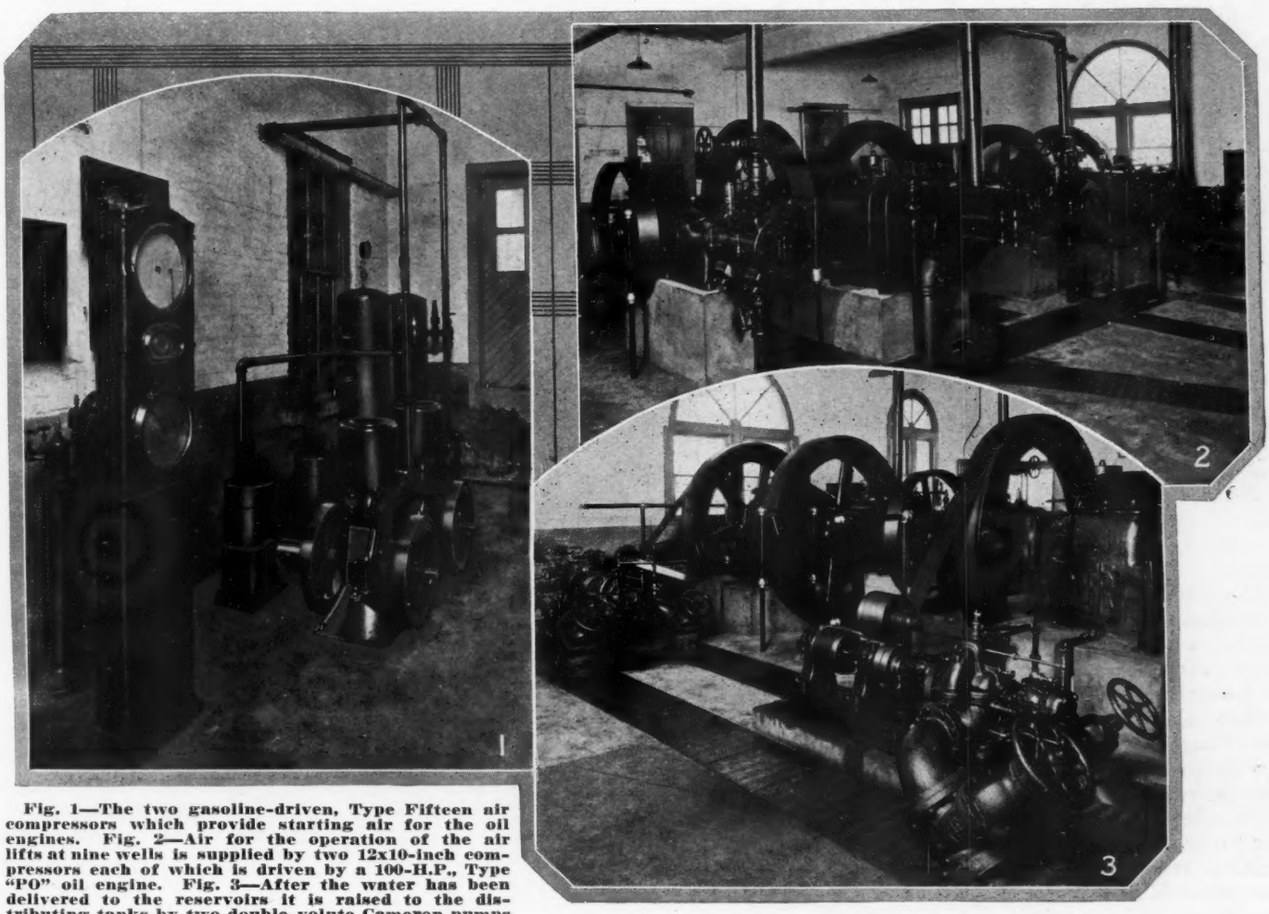


Fig. 1—The two gasoline-driven, Type Fifteen air compressors which provide starting air for the oil engines. Fig. 2—Air for the operation of the air lifts at nine wells is supplied by two 12x10-inch compressors each of which is driven by a 100-H.P., Type "PO" oil engine. Fig. 3—After the water has been delivered to the reservoirs it is raised to the distributing tanks by two double-volute Cameron pumps which are belt driven by the oil engines.

Matlack, the water superintendent, who had supervised the plant for more than twenty years and who had drilled all the 8-inch wells then in service, it was decided to continue the air-lift system because of its extreme simplicity and established reliability—only changing the piping and deepening the wells if necessary to get better economy and added submergence.

As the ultimate selection of new pumping equipment would depend upon the characteristics of the wells, which extended fully 900 feet in two directions from the pumping station, arrangements were made with the Ingersoll-Rand Company to conduct a thorough examination. The results of a typical test are shown by an accompanying table.

As the determination was to use the present stratum, it was decided to deepen all the 8-inch wells to obtain greater submergence. This was done by sinking a 6-inch pipe 100 feet below the former bottom of each well, and then by cutting off that pipe just short of the 100-foot extension. The 200 feet of discharge pipe required in each case was composed of 90 feet of 2-inch pipe at the bottom joined to an upper section of 110 feet of 2½-inch pipe. Previously the piping had been uniformly of 4 inches from top to bottom of the 100-foot wells. A ¾-inch air line was employed as before. The changes gave approximately 70 per cent. submergence instead of the former 40 to 45 per cent. The increased efficiency and steady flow thus obtained amply justified the expense entailed.

The next step—a really big one—called for new pumping apparatus. Electric drive, with power obtained from a near-by transmission line leading to a station fifteen miles away, was considered; and there was also taken under advisement the suggestion that we use our own single electric-generating set with switching facilities by which we could draw upon the power company for current in emergencies. But these alternatives were superseded by a scheme involving the installing of duplicate compressors, each driven by its own oil engine, and by dependence upon either triplex or centrifugal pumps, actuated by the same or separate engines, as a means to distribute the water after it had been raised to the surface by the air lifts. It was agreed by the responsible authorities that each pump should have a capacity of 500 gallons per minute, with a suction lift of 15 feet

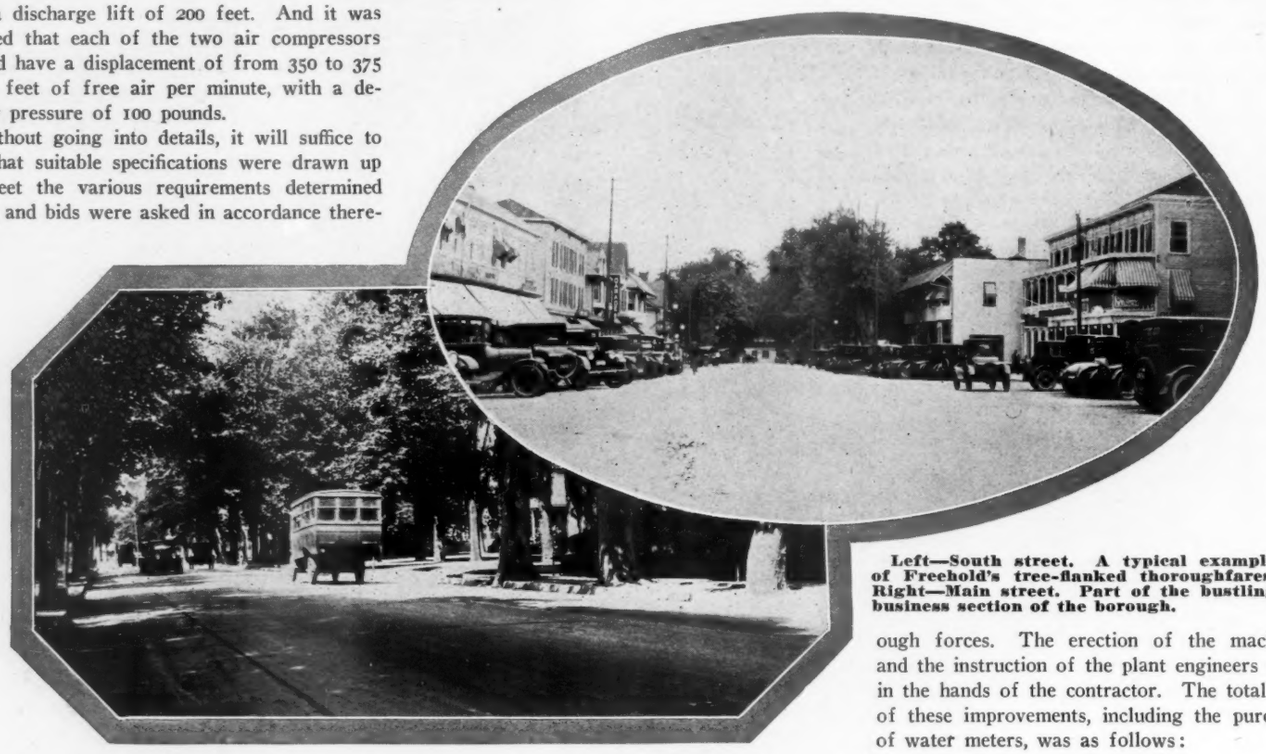
and a discharge lift of 200 feet. And it was decided that each of the two air compressors should have a displacement of from 350 to 375 cubic feet of free air per minute, with a delivery pressure of 100 pounds.

Without going into details, it will suffice to say that suitable specifications were drawn up to meet the various requirements determined upon, and bids were asked in accordance therewith. In response, different combinations of equipment were offered, all of which had merits that added to the difficulty of making a selection. Points were visited where machines could be seen in operation, and trips were made to plants where certain oil engines tendered were manufactured. After due consideration, the contract was finally awarded to the Ingersoll-Rand Company for two 100-H.P. Type "PO" oil engines, each directly connected, through an IR floating ring coupling, to a 12x10-inch "ER-1" air compressor. It was also provided that each engine should be belted to a single-stage, 4-inch, Cameron, centrifugal pump.

This equipment appeared to offer the best solution of our problem. The engines are of the 4-cycle, direct-injection type — starting without preheating or electrical ignition. In this type of engine the ignition is obtained by heat of compression only. Inasmuch as the engines, the compressors, and the pumps were all the product of the successful bidder, this meant the avoidance of any divided responsibility in the future; and, furthermore, the entire layout was very compact and necessitated the least change in the existing pump house.

Actual installing was carried out as prearranged; the enlargement of the building, the construction of the foundation, the placing of two 8,000-gallon oil storage tanks, and the putting up of all air, water, oil, and exhaust piping was done by the borough forces. The erection of the machines and the instruction of the plant engineers were in the hands of the contractor. The total cost of these improvements, including the purchase of water meters, was as follows:

Meters	$16,397.35
Deepening wells	4,947.83
Duplicate engines, compressors, and pumps (contract)	24,300.00
Borough work	6,651.06
	$52,296.24



Left—South street. A typical example of Freehold's tree-flanked thoroughfares. Right—Main street. Part of the bustling business section of the borough.

Month	Average operating Hours per day 1923	1924	Water pumped 1,000 Gals. 1923	1924	Approximate Fuel costs Coal 1923	Oil 1924	Engineers' Salaries 1923	1924
Jan.	24	12	16,570	10,570	$1715	$114.00	$563	$420
Feb.	"	11.7	15,510	8,930	1435	96.50	"	"
Mch.	"	10	17,007	9,050	1470	97.50	"	"
Apr.	"	10	17,050	8,460	1375	91.50	"	"
May	"	11	18,560	9,280	1510	100.00	"	"
June	"	11.5	19,690	9,210	1500	99.50	"	"

Air receivers placed outside the pumping plant. The operating air is distributed from these receivers to the different wells.

The item "borough work" includes engineering, bond-issue costs, alterations to building, piping, the two oil storage tanks, and all labor.

It was a decidedly eventful day when, on November 1, 1923, the old boilers were slowed down and the new plant took up the load. That this has led to considerable benefit to the borough is shown by the service record given in the above table covering the performance of the old steam plant during the first six months of 1923 and the work of the new equipment during the first half of 1924.

In 1923, the plant was operated on 12-hour shifts with two men and a fireman in the day-

time and one man at night. In 1924, the plant was operated on 8-hour shifts with one man in each shift, a relief operator permitting each man to have two days off every month. The pumping costs per 1,000 gallons, with the new equipment, are:

Fuel oil	$0.0107
Lubricating oil	.0015
Engineers	.0450
	$0.0572

The charge for engineers' services is somewhat high inasmuch as the equipment is working only about half time although the plant is covered all the time. The usual procedure is for each operator to run the machinery from three to five hours during his tour of duty so as to keep the reservoirs full. The oil engines, due to the ease and the economy of starting up and shutting down, are more adaptable to the present method of operating than was the old steam plant.

Perhaps the case may be stated in another way: the fuel—embracing coal, freight, and cartage—to pump the water required in 1923 involved an outlay of $18,040.01, while the cost of fuel for the same service in 1924—also including the charges for freight and cartage—will amount approximately to $1,200. This represents a reduction of $16,840.01 in the item of fuel. It might be mentioned here that with the installing of individual water meters on the premises of every user about the time the oil engines were ready to run, the monthly consumption of water in the town dropped from 17,000,000 to 9,380,000 gallons, thereby lessening the income to the borough from this source. Even so, the new equipment has fitted in very well with the complete metering of the borough, for without this modern machinery the reduced revenue due to metering would have presented a serious financial handicap. In other words, the economies now possible at the pumping station have saved the day.

A bakery at Reading, Pa., producing 200,000 pretzels per day, uses 5,000,000 cubic feet of gas annually for their baking. Reading, by the way, is acquiring the name of "Pretzel City."

New 200,000-gallon tank with the older standpipe in the distance.

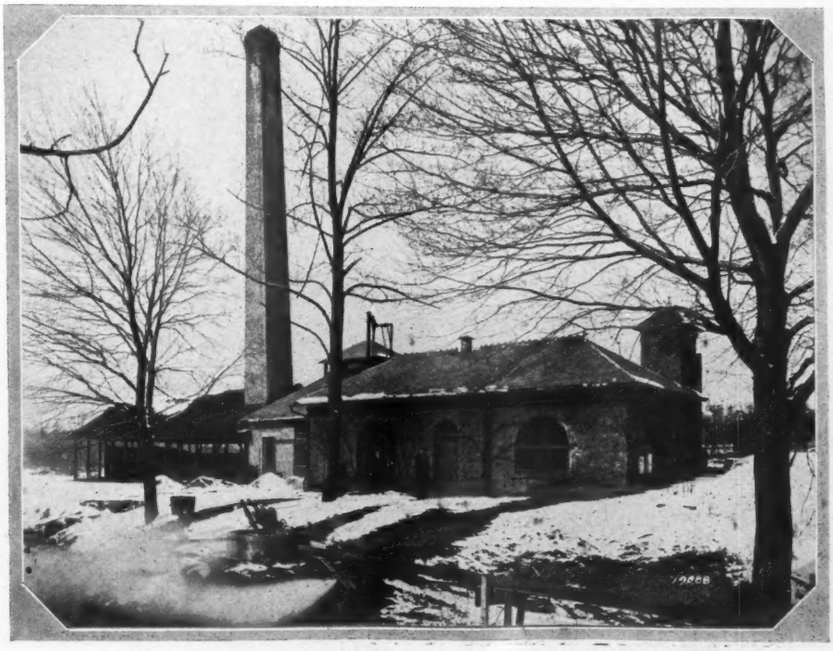
MINING POSSIBILITIES IN TURKEY

NEXT TO agriculture, the mining industry of Turkey should become the chief mainstay of that country. Although no comprehensive geological survey has ever been made, it is generally understood that Turkey is rich in mineral deposits of various kinds, including coal, chrome, emery, lead, copper, boracite, meerschaum, salt, marble, mercury, antimony, gypsum, etc. In fact, all the minerals named are now being mined, and promise well for the future of the industry.

Collieries in the western section of Kastamuni, using a port on the Black Sea as the principal outlet, have been operated for the past 25 years. They are now supplying about 1,000,000 tons of bunkering coal annually; and their output, as well as that of coal mines in other sections of Anatolia, is likely to increase.

What is needed to develop the Turkish mining industry, according to the American Consul General at Constantinople, are capital and railways. Even so, the copper mines of Arghana have been made to yield as much as 1,500 tons of black copper a year by means of hand picks. The ore so extracted is carried on mule or camel-back to Tokat or Mersina for smelting—journeys that take many days to make in this fashion. Easier of access and operation are the copper, silver-lead, zinc, and manganese deposits located in the Province of Trebizond; but here, too, the lack of proper transportation facilities retards development.

The Balia Karaidin lead mine in the Province of Brusa is at the present time, perhaps, the most successful mining enterprise in Turkey. Here are produced yearly over 12,000 tons of argentiferous lead and more than 5,000 tons of blendes containing 41 per cent. zinc. The meerschaum mines near Eskishehr, which belong to the government, have a normal annual output of substantially 245 tons. These mines constitute the world's chief supply of this mineral.



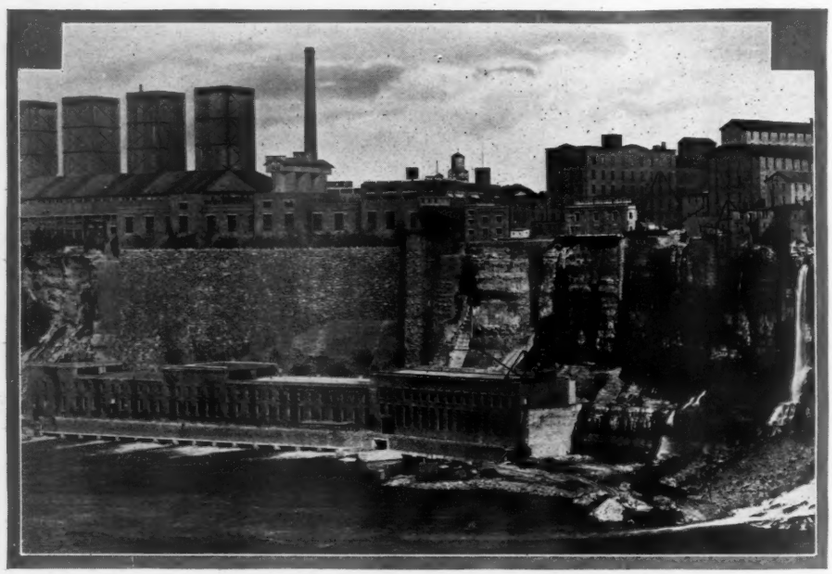
Exterior view of the Borough Water Works, Freehold, N. J.

A BIG NATURAL POP-GUN

THE ANNUAL closing of the Upper Missouri, in South Dakota, seems to be about as perfect a job of freezing-up as it is possible to imagine, and this accounts for a curious phenomenon that sometimes occurs there. A government naturalist, conducting investigations in that region, tells how one day in December there came to his ears a heavy report which must have been heard for miles around. Returning to the place where he had crossed the river in the morning, he found a large hole of irregular shape—say 100 feet square—in the solid ice, which averaged more than 2 feet thick. The theory readily suggested is that imprisoned air accumulates in a favorable spot and is compressed by the powerful current until the ice can stand no more. Then it gives way—going off with a bang.

STEAM SHOVELS OPERATED BY COMPRESSED AIR

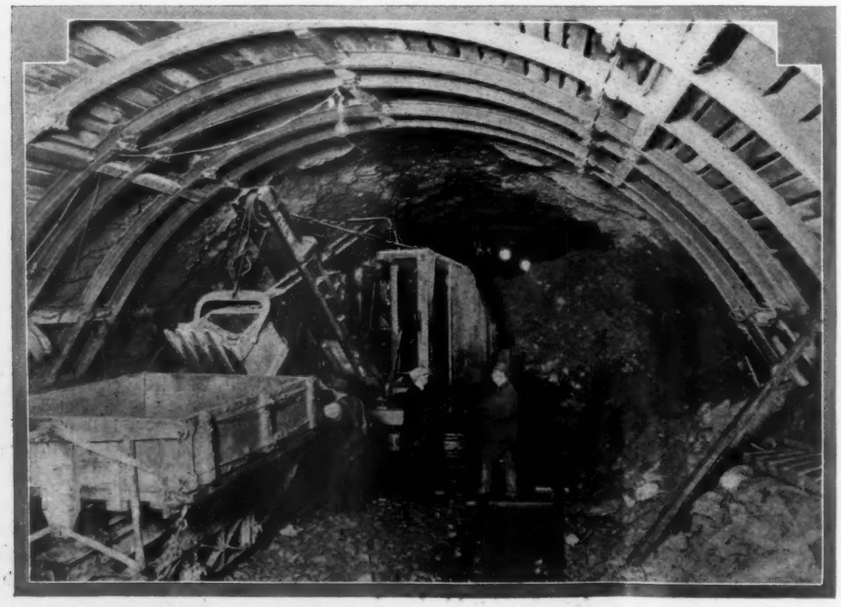
IN THE WORK of excavating, it is not always practicable to operate big shovels by steam, as designed. It is therefore becoming the practice, wherever digging must be done in close quarters, such as in tunnels, etc., to use compressed air instead when that adaptable operative medium is available.



Plant of the Niagara Falls Power Company while undergoing enlargement. The picture gives little if any idea of the tremendous amount of electrical energy being developed by the hidden waterwheels.

In 1921, the Niagara Falls Power Company was obtaining water for driving its hydro-electric turbines through the medium of a canal traversing a busy section of the city of Niagara Falls. This canal carried the water from the upper Niagara River to a forebay, situated above the lower river, whence it descended through penstocks to the power plant below. When added power demands necessitated almost doubling the capacity of the station, a new waterway had to be provided. So a tunnel was planned to run parallel with the old canal and about 140 feet below ground. It was to be 36 feet in diameter rough cut, 32 feet finished size, and 4,300 feet long through solid limestone.

Preliminary to the main tunnel work, two vertical shafts were sunk to a depth of 140 feet: one about 950 feet from the intake end and the other approximately 1,500 feet from the outlet forebay. Excavating was to proceed from five points simultaneously—that is, the tunnel was to be advanced in both directions from each shaft and also from the outlet end. It required about three months to sink the shafts. In the meantime, the cabs of three standard Thew steam shovels, of ¾-yard capacity, were replaced by low-shelter cabs to protect the operators from rock that might become detached from the tunnel roof. Short booms and short dipper sticks were substituted for those of regulation size so as to enable the shovels to work in confined quarters. Next, the boilers were removed; and, instead of steam, compressed air at a pressure of 90 pounds was conveyed directly to the feed lines of the steam engines. The air, of course, having been supplied primarily for operating the rock drills used to drive the tunnel.



Air-operated steam shovels meeting where opposing headings have been holed through in the tunnel.

Each heading was first cut its prescribed length and arched with steel forms; and broken rock was dry packed behind the forms as the heading progressed. The rest of the tunnel was cut in three benches. The rock was loaded by the shovels into 4-yard cars which were hauled by electric mine locomotives to the two shafts, where the rock was lifted by bucket hoists to ground level. Drilling and shooting were done during the day, and the loose rock was removed by the shovels—one in each drift—at night. The modified steam shovels handled and loaded all the rock excavated without the need of hand mucking; and the daily record sheet of the Read-Coddington Company, the contractor, shows that the shovels functioned like clock work. One day only was lost due to shovel trouble in the two years required to complete the undertaking. After the shovels had finished their work underground, they were restored to their original condition and used to help clean out and to smooth the walls of the aforementioned canal.

CARBON BLACK

ONE OF THE most remarkable of the very modern industrial products is carbon black. Curiously enough it is little indebted to any inventor or investigator and is not a thing that can be monopolized by patentees or others. It is made by what may be called the incomplete combustion of natural gas or, to express it more plainly, by burning gas, having a restricted air supply, and by allowing the flame to come in contact with a cold metallic surface. While it is thus a species of lampblack, it has qualities of its own which give it a place unique among working materials.

For example, it is remarkably fine—being entirely devoid of grit, lustrous in color, and generally adaptable as a pigment and a toughening property in rubber compounds. Besides its use in the rubber industry, it is now the most important ingredient in printers' ink, China and India ink, black and gray paints and enamels, stove and boot polishes, phonograph records, type-writer carbon paper, glazed paper, crayons, tarpaulins, insulating materials—in short, it fits in wherever a black filler is required. With little special equipment it can be produced in unlimited quantities where natural gas would otherwise go to waste; and, though bulky, it is light for transportation.

Compressed Air Hastens Letters On Their Way

By THE STAFF

HUNDREDS of thousands of persons travel daily upon the subway routes of New York City, saving an enormous amount of time because of this underground system of rapid transit. Similarly, millions of pieces of mail are transported each 24 hours through pneumatic pipe lines laid beneath the streets of the Metropolis—in this way speeding up the dispatch and the delivery of first-class postal matter to an extent but little realized by the benefited general public.

The pneumatic-tube method of forwarding mail from one postal station to another is the outcome of an effort to hasten the movement of such matter and to lessen the use of city highways to effect these transfers. Congested traffic in busy thoroughfares has tended to slow up the travel of mail-laden trucks or to make their rapid progress an added menace to other vehicles and to pedestrians. Further, as municipal growth has extended the zone of city mail delivery and collecting it has become increasingly difficult to link the various primary branch stations with the railway stations wherever motor trucks and horse-drawn wagons have been relied upon for this work so essential to business and to social communication. Therefore, pneumatic-tube systems have been devised which can send to and fro at considerable speed large volumes of first-class mail matter unhampered by weather conditions or the state of traffic in the overlying streets. What is true of New York applies with equal force to other large centers of population.

It may not be commonly known, but there are in operation in the United States a total of 56.58 miles of double-tube lines transferring mail by the aid of compressed air in five of our cities. This mileage is divided as follows:

Greater New York	27.779	miles
Boston	6.774	"
Chicago	10.040	"
St. Louis	1.988	"
Philadelphia	9.999	"

Instead of a motor truck or a slower-moving horse-drawn vehicle, the mail matter is put into steel cylinders 21 inches long having an internal diameter of 7 inches. Depending upon how the letters are packed, a cylinder of this description will hold anywhere from 500 to 600 letters. The forward end of the cylinder is permanently closed and is provided with a leather buffer which absorbs the force of impact when the container is suddenly brought to rest at the end of its journey. Furthermore, there is an encircling collar—made of rubber and canvas—at each end of the carrier, and these rings serve to steady the carrier in the tube and to seal the passageway so that the full pressure of the impelling air can be counted upon to shoot the cylinder forward at a speed of 30 miles an hour.

The rear end of the container is equipped with a hinged cover which can be opened and swung to one side to facilitate the insertion of letters, etc. When ready for dispatching, the cover is closed and locked; and the arrangement is such that the cover stays locked as long as the carrier remains inside the tube. Indeed, the cylinder cannot be pushed into the tube until the cover has been properly sealed.

The pneumatic tubes are composed of numerous sections of cast-iron pipe, each of which is about 12 feet long and bored by machinery to a finished internal diameter of 8⅛ inches. These tubes are successively assembled with great care; and when ready for service they provide conduits of uniform diameter having very smooth inside surfaces. Compressed air at a pressure ranging from 4 to 12 pounds, depending upon the length of the run, is the motive force which shoves the containers onward at the rate already mentioned. In New York City, for instance, the carriers are dispatched every 10 seconds; and this continues for a period of 20 hours every day.

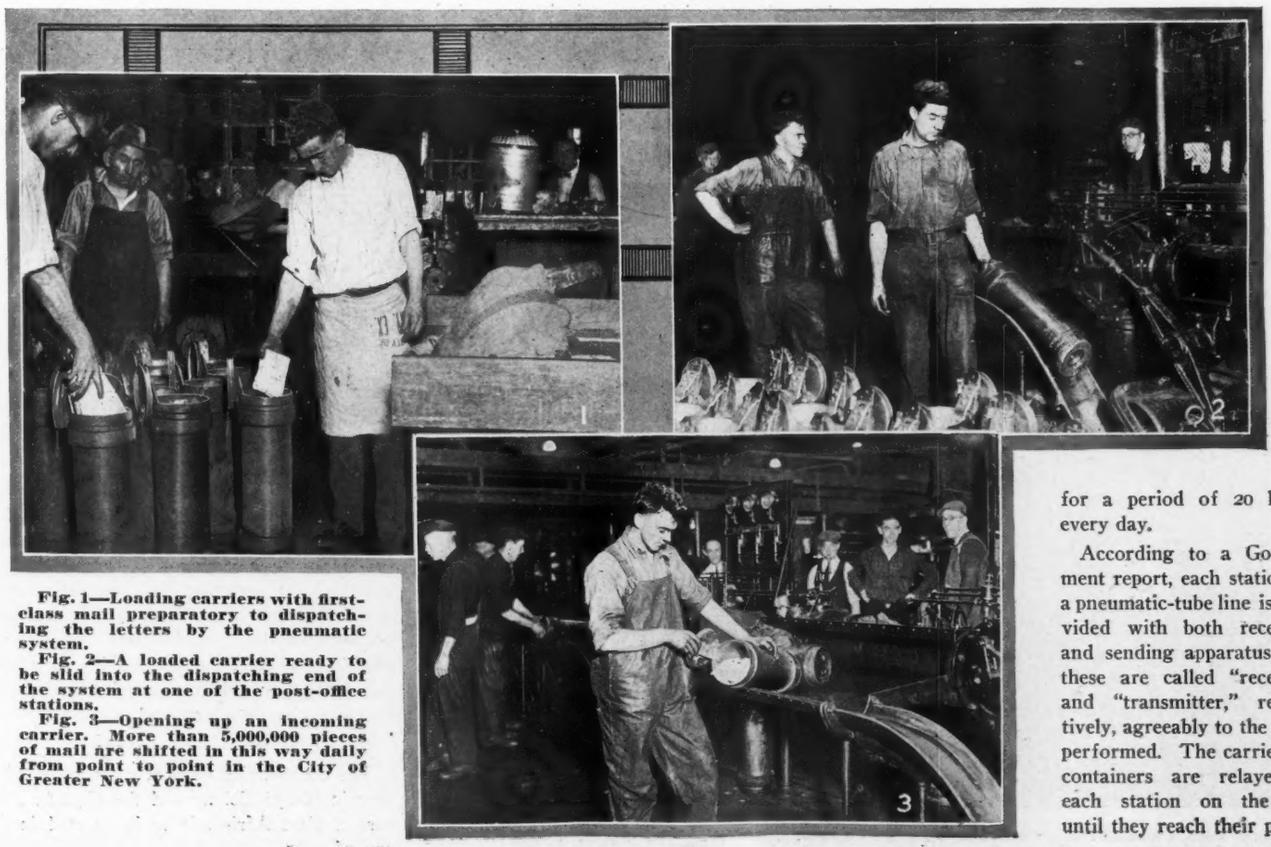


Fig. 1—Loading carriers with first-class mail preparatory to dispatching the letters by the pneumatic system.

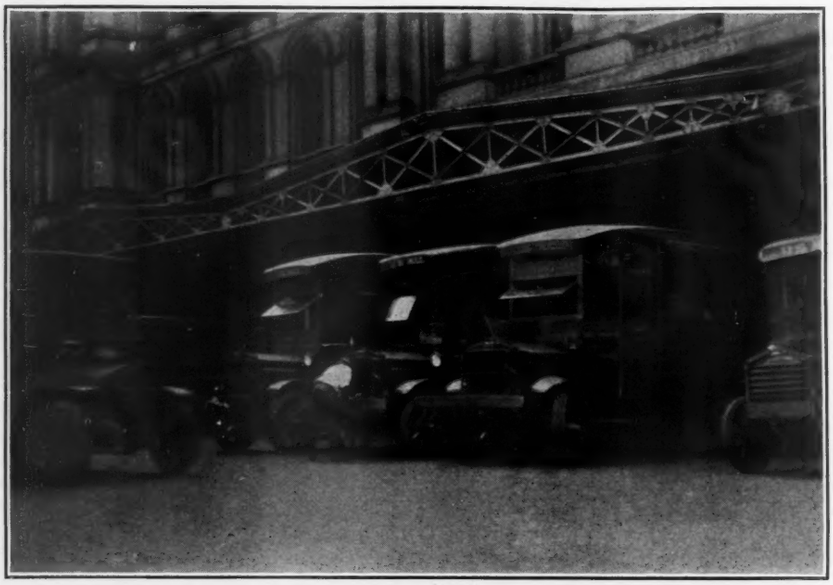
Fig. 2—A loaded carrier ready to be slid into the dispatching end of the system at one of the post-office stations.

Fig. 3—Opening up an incoming carrier. More than 5,000,000 pieces of mail are shifted in this way daily from point to point in the City of Greater New York.

According to a Government report, each station on a pneumatic-tube line is provided with both receiving and sending apparatus, and these are called "receiver" and "transmitter," respectively, agreeably to the work performed. The carriers or containers are relayed at each station on the line until they reach their prede-

termined destinations. The most common type of transmitter is one that is set at an angle of 45 degrees in the floor of a station and arranged so that the cylinders will drop by gravity into an air chamber having valves or gates at its upper and lower ends. The container is dispatched by placing it in a trough and with its forward end resting against the upper valve. At fixed intervals, regulated by a time lock, the valve opens and the carrier is free to drop into the air chamber. Air pressure is then exerted against the rear of the cylinder, and this forces it through the lower valve and into the pneumatic tube. Once in the tube, a current of air sends it forward to the next station, where it remains to be unloaded or whence it is relayed upon the next stage of its journey.

The subject of pneumatic mail tubes is one that might be developed into a longer and far more informative article, but limited space forbids this at present. It should be of interest, however, to mention that out of 8,000,000 pieces of mail handled in the various post offices of Greater New York every 24 hours fully 70 per cent. is moved by way of the tube system, and that 32 per cent. of this volume of postal matter is hastened in its transmission anywhere from 14 to 24 hours—making train connections which might otherwise be missed. Finally, it is authoritatively reported that the pneumatic-tube system in the Metropolis has made it practicable to reduce by 3,500 miles daily the travel of mail motor trucks.



Part of New York's large fleet of mail motor trucks loading at the downtown post office near City Hall.

New York's southernmost station is in the Custom House, at the right, where a large volume of postal matter is handled daily.

HIGH-GRADE SUGAR FROM ARTICHOKES

LEVULOSE IS the sweetest and one of the most nutritious members of the sugar group. It has therefore the intrinsic qualifications of a staple commodity for ordinary commerce. However, on account of the great difficulties hitherto encountered in its preparation, it has been one of the most expensive of the sugars—selling for from $30 to $110 a pound, depending on its source.

A method has now been devised, as a result of research work on the part of the United States Bureau of Standards, by which it is feasible to make the sugar from dahlias or Jerusalem artichokes at a relatively low cost. The latter plant offers a particularly promising source of supply, inasmuch as it is extremely prolific and its agricultural requirements are very simple.

The process by which levulose can be obtained from artichokes consists of juice extraction, conversion and clarification, precipitation of the sugar with lime, and crystallization from aqueous solution. Each of these steps has involved extensive study covering in the aggregate a period of several years. The resulting product is a brilliantly crystalline substance of high solubility that is somewhat less stable in humid atmosphere than cane sugar, but of great sweetness and palatability. It is estimated that from 80 to 85 per cent. of the levulose in the extracted juice may be recovered in the form of crystalline sugar.

IMPROVED TYPE OF GAS HOLDER

A NEW TYPE of gas holder, originating in Germany, is to be erected for the Public Service Electric & Gas Company at Harrison, N. J. The tank, a so-called "waterless" holder, is to be 333 feet high, is to have a diameter of 254 feet, and will have a capacity of 15,000,000 cubic feet—in short, will be one of the largest structures of its kind in the United States.

As the name implies, the water seal generally employed to prevent gas leakage is done away with: a tar-coated fabric is used instead. This means a great reduction in weight to be carried, and, consequently, a waterless holder can be built of lighter steel plates. Furthermore, there is no longer need to provide steam heat for the purpose of keeping the water from freezing in cold weather.

The Harrison gas tank will be polyhedral in form, and will consist of a single, rigid shell instead of the familiar series of big telescoping cylinders. Engineers from all over the country are awaiting the completion of the structure with much interest. It is also reported that the United States Steel Corporation is contemplating the erection of a similar but far larger holder—one of 50,000,000 cubic feet capacity—at Gary, Ind.

The construction of nearly 300 miles of railway in Kenya Colony and the Uganda Protectorate, East Africa, is to be started in January of 1925.

Progress on the Big Creek Hydro-Electric Project

Driving a Thirteen-Mile Tunnel Through Hard Rock and Difficult Ground in Order to Link Florence Lake With Huntington Lake

PART VI

By D. H. REDINGER*

IN this concluding installment of the story of the Big Creek Project, particular attention is given to operations in connection with the driving of Florence Lake Tunnel—one of the most conspicuous of the engineering tasks of this whole magnificent undertaking.

When work on this tunnel was begun there were no lines of communication other than steep mountain trails in the region between Florence Lake and Huntington Lake—the intervening country being covered with virgin forests. In the summer of 1920, Camp 60 was established at the outlet portal, which is located at the eastern end of Huntington Lake. It was at first not deemed possible to economically construct a road from Huntington Lake to the necessary camp sites because of the rugged nature of the terrain. Some means of transportation were, of course, absolutely needful on account of the large amount of materials and supplies required to keep such a job going over a period of several years, and just what quantities have to be handled can be gathered from the fact that to last through a winter approximately 25,000 tons have to be hauled to the various camps from June 15 to October 1.

The use of aeroplanes was seriously considered, but after some trial trips were made in the vicinity of Los Angeles the scheme was abandoned as impracticable and more study was given to the building of roadways.

The path finally decided upon led over Kaiser Pass, at Elevation 9,300, where a road could be constructed at a reasonable cost. This work, which was started from Huntington Lake late in the summer of 1920, was pursued from five camps; and in about two months 11½ miles of good road, connecting the outlet portal at Camp 60 with Camp 61 had been completed.

A permanent base of operations was established at Camp 61 in order to carry on tunneling during the winter of 1920 and the winters succeeding it. This camp lies at Elevation 7,100; and there are seldom more than five months in the year during which snow does not lie on the ground in depths up to ten feet. By October 1, permanent winter quarters were set up at Camp 60; and it was at that end of the long tunnel tangent that the open cut for the outlet portal was begun. The tunnel between Camps 60 and 61 has a length of 6½ miles. The first set of timbers was placed at Camp 60 on October 15, when the underground work was taken in hand.

Fig. 1—Tunnel heading near Camp 63. From seven to eight tons of steels are handled in drilling a round. Fig. 2—A finished section of Tunnel No. 6 with concrete lining in place. Fig. 3—Tunnel muck train at Camp 60. Overhead can be seen the wood-stave blower pipe, suspended from the roof, installed for ventilation.

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As far as the first winter's activities were concerned, Camp 61 was in readiness by the middle of November, 1920, to start operations on an open cut at the portal of the adit. The work of excavating that was being pushed from both of these camps was at first slow and most difficult, and required heavy timbering. Running sand was encountered in the adit at Camp 61, and in the outlet portal considerable water was struck besides having to deal with such materials as boulders, decomposed granite, sand, and mud.

Various methods were employed to cope with these problems in both headings; but it will suffice to say that the work was confined chiefly to hand labor, in small timbered drifts, using breast boards and a large amount of spiling to hold back the flowing sand and caving ground. Mucking was done with Armstrong Shuveloders; and from four to six 1-cubic-yard-capacity cars, hauled by storage-battery locomotives, were utilized to remove the spoils.

In order to run a double track, the adit at Camp 61 was made the full size of the tunnel cross section, which is 15 feet wide, has a central height of 15 feet, and a roof arched on a 10.8-foot radius. The tunnel is unlined, except in places where bad ground was met, and is expected to give a flow of approximately 1,500 second-feet on a grade of 3 feet per 1,000.

After six months of continued effort the adit at Camp 61 was less than one-third finished, and, of course, no excavating whatever had been done on the tunnel. To speed up operations, it was finally decided to sink a shaft to the main tunnel grade west of the adit. This shaft was located 1,655 feet from the intersection of the adit and the tunnel and in the direction of Camp 60. Work was commenced on this shaft on April 15, 1921, and was completed to tunnel grade, a distance of 247 feet through hard granite, on July 23. From the bottom of this shaft the tunnel was driven toward the latter camp by ordinary hard-rock methods, using the heading-and-bench system.

Good progress was made despite the handicap of having to remove all the excavated material by equipment operated by an air hoist at the top of the shaft. To further speed up operations so as to reach the tunnel line, another 13x22-foot shaft was sunk to adit grade about 170 feet from the point of intersection of the adit and the tunnel and towards the adit portal. This second shaft was 87 feet deep and penetrated solid granite. It was started June 25, 1921, and was sunk to tunnel grade in 49 days. This permitted work at two more headings—one a pioneer drift along the adit towards the outlet, making it possible to attack the sand from both ends of the adit, and the other a heading along the adit in the direction of the tunnel. On December 17, 1921, the small pioneer drifts in the adit were holed through; and within two months the excavation of the adit was completed. Mucking operations by way of the first shaft were then discontinued, as muck trains could be hauled through the adit.

On April 6, 1922, the 1,600-foot section of tunnel west of the first shaft reached the section being worked from the second shaft, and was broken through. By that time the heading west of the bottom of the second shaft had been advanced 1,300 feet, bringing the total progress at Camp 61 up to 2,900 feet of tunnel and 1,086 feet of adit. In the meantime, a stretch of 2,925 feet had been driven at the outlet portal at Camp 60.

Mucking operations through both of the shafts at Camp 61 being no longer necessary, attention was centered on the heading going west from the adit. Good progress was made from that time on by reason of better organization and more uniform rock, as well as improved equipment.

During the summer of 1922, the construction road was extended from Camp 61 to Florence Lake; and by late fall Camps 62 and 63 had been established and well stocked with materials, machinery, and supplies for their eight months of winter isolation. Each year since the building of Florence Lake Tunnel was started, there have been days when snow storms raged to such an extent that transportation by ordinary means, such as teams and sleds, was quite impossible. For emergency use, it was therefore found expedient to get from Alaska a dog team and its driver, Jerry Dwyer. With six dogs, it is not at all difficult to draw a sled with a load of 200 pounds over the snow and ice, and this load ordinarily represents the first-class mail to be handled when horse and sled haulage is out of the question. And let it be remarked, that Jerry Dwyer and his team have rendered valuable assistance during several severe storms.

For the first six weeks in 1923, the west heading was advanced on an average of 83 feet per week, while at Camp 60 the average heading progress was 112 feet per week. The heading-and-bench method was practiced at both headings with drills on horizontal as well as vertical bars. When the bench was being drilled the horizontal bar was utilized, while the vertical columns were used for drilling the top heading. The depths of the holes in the top headings varied from 10 to 14 feet, and the total number in a round ran anywhere from 40 to 50.

It was found that with three 8-hour shifts the work could be done to best advantage. Furthermore, the law has limited work underground to eight hours. It is difficult to arrange an altogether satisfactory schedule because one crew cannot always get a round of holes drilled during an 8-hour shift, which makes it necessary to have a second crew complete the round. This is not desirable, so each shift on the job finishes the round it starts.

On account of the time required to complete Florence Lake Tunnel, it was thought worth while to fit the equipment to suit the tunnel section. Taking the cross section as a basis, and setting aside that part of it required for the operation of an air-driven shovel, dump cars were built of a size that could be operated in the remaining available space. It was necessary to keep their height down to a point which would permit loading by the shovel dipper. These special cars have 14-inch wheels and are 4½ feet high.

It might be well at this point to mention some of the improvements which served to make for progress after the work was better organized. By replacing the small-capacity Shuveloaders with a special type of No. 25 Marion steam shovel, operated by compressed air, the time required for mucking was greatly reduced. The principal modifications in these shovels consist of minor changes in standard design that enable them to work effectively in a 15x15-foot tunnel. Two such shovels are in use in Florene Lake Tunnel, and were made especially for it by the Marion Shovel Company. At the present time they are both at the Camp-60 end of the job. There are five more shovels engaged in excavating: two at Camp 61, two at Camp 62, and one at Camp 63. These were of Marion type No. 20, but were cut down to fit the tunnel section.

The removal of muck was speeded up by replacing the 1-cubic-yard dump cars with others having a capacity of from 4 to 6 cubic yards and by transferring the empties, for loading, from the track behind the shovel to the main track alongside—the work of transferring being done by means of a suitable derrick, attached to the rear end of the shovel, operated by a "Little Tugger" air hoist.

The substitution of locomotives with a combination storage battery and trolley for those of the straight storage-battery type makes it possible to haul heavier trains up to a point within 800 or 1,000 feet of the heading and enables locomotives to go wherever the track is clear without dependence upon flexible leads or trolley wires, which are subject to destruction by flying rock fragments. The locomotives are of the Baldwin-Westinghouse 8-ton type; and, in addition to the regular trolley, are equipped with Hobbs 17-plate storage batteries rated at 220 ampere-hours and 275 volts, the same as the trolley voltage.

By standardizing the drilling equipment, and by using X-70 Ingersoll-Rand rock drills instead of the smaller No. 248's of the same make formerly employed, the tunnel headings are being pushed forward at a faster rate.

By means of larger blowers and 24-inch, wood-stave piping the working faces are cleared of gases after blasting in much less time than when the smaller blowers with their 12-inch, iron pipe were in service. Wood-stave piping was first preferred for two reasons, namely, there is not so much danger of collapse after concussion, and if a heavy rock fragment falls on it the result is only a hole which can readily be patched. Iron pipe, on the other hand, if crushed or shattered requires the renewal of a section or sections.

The No. 7, positive type Root blower, which has displaced a No. 3 of the same kind, handles the ventilation very well for distances up to 11,000 or 12,000 feet. For longer stretches it is necessary to add another blower to the line, which acts as a booster.

After two years of experience with wood-stave piping for ventilation it has been found unsatisfactory owing to the fact that it dries out and, in doing so, shrinks to such an extent that it calls for continuous maintenance work in the way of putting on bands and drawing the staves together. Water jets have

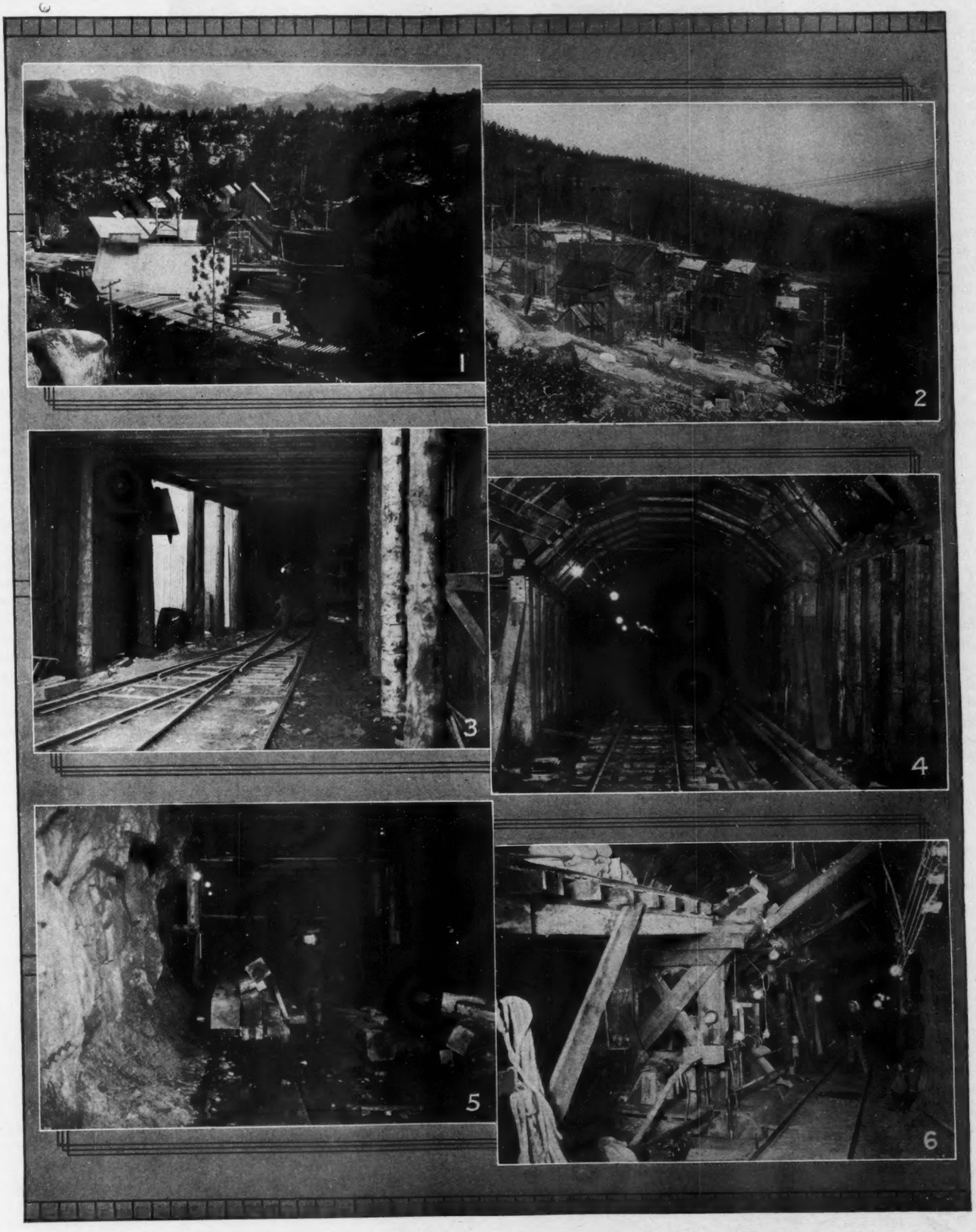


Fig. 1—Camp 62. The long-roofed structures extending into the foreground are to protect the tracks from snow.
Fig. 2—Camp 61. The transmission lines seen near by carry current to the various camps and outdoor substations.
Fig. 3—Portal, at Camp 62, of Adit No. 1 of Tunnel No. 6.
Fig. 4—Double timbering in Adit No. 2 of Tunnel No. 6. This will be concreted before the tunnel is completed.
Fig. 5—Placing timbering in Tunnel No. 6 at west heading of Adit No. 2.
Fig. 6—Concreting plant in Tunnel No. 6 at Adit No. 2, west. The material is being placed by a Webb-Cox pneumatic concrete gun.

been inserted in the line at various places; but, while they have remedied the situation somewhat, it has been impossible thus to relieve the trouble entirely. Tests have recently been made with corrugated iron pipe, 24 inches in diameter, with a view to adopting it if it proves satisfactory. It has been determined that corrugated piping will serve the purpose provided a thin, smooth liner is placed inside to cut down the friction which would otherwise result on account of the corrugations. Without the liner the diameter would have to be increased. With piping of this description it is practicable to use 20-gage material, which has nearly three times the compressive strength of a smooth iron pipe made up of 12-gage material.

Portal, at Camp 61, of Adit No. 2 of Tunnel No. 6. Track above ground on slope of hill was used for mucking at the vertical shaft.

The blower pipe is run up to within 300 feet of the tunnel heading and is suspended from the roof by suitable hangers so as to give more floor space along the tunnel wall for storing ties, piping, rails, etc. Another advantage is that the gases generated by blasting, which ordinarily rise, are somewhat easier to exhaust than when the blower pipe rests on the floor. For about an hour after a round is blasted, the blowers are operated so as to exhaust; and to assist the blowers to withdraw the powder smoke the use of an air curtain has been found to be very effective. To create this air curtain, a 1-inch pipe is laid on the floor at right angles to the center line of the tunnel and about 75 feet from the intake end of the blower pipe towards the portal. This pipe is perforated with holes 3/32 inch in diameter, spaced about 4 inches apart, and is turned just enough to point the holes toward the end of the suspended blower pipe. Before a round is blasted, and when the last man leaves the heading, air is fed through this line. In this way a curtain is formed that tends to hold the gases between it and the tunnel heading, thus enabling the blower to clear the working face quicker than ordinarily. By this method it is feasible for tunnel crews to return to headings from 10 to 15 minutes sooner; but in no case is a man allowed to go back until after half an hour has elapsed. This is a safety-first measure against delayed holes. After a blast, a crew generally resumes operations at a heading in from 30 to 45 minutes.

The various companies that supply blasting powder have been endeavoring to provide one that would generate the smallest amount of poisonous gases; and a means to this end is the use of a special kind of paper wrapper. The explosive utilized exclusively at the present time—a 40 to 60 per cent. gelatine powder—is a great improvement in this respect. All blasting in the heading and the bench is done with delay-action exploders connected in multiple and ignited electrically from a 440-volt circuit.

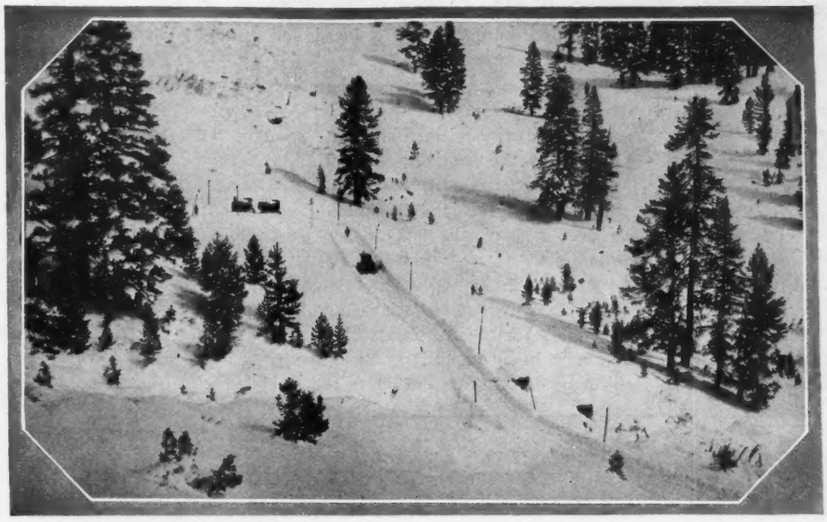
In order to load the holes more efficiently, a standard has been adopted in the matter of cartridges—namely, 1¼x12-inch cartridges are loaded in the bottoms of the bench holes, while those for the heading holes are 1¾x12 inches in size.

A great deal of bad ground has been encountered in driving Florence Lake Tunnel; and, at present, the indications are that approximately 10 per cent. of its total length will have to be concrete lined. It is necessary to carry on this part of the undertaking while excavating is going on; but as preference is always

Map showing positions of Huntington Lake and Florence Lake Reservoir, together with the general alignment of the associate tunnel.

given to tunnel progress, the work of concreting is slowed up from time to time. Most of the lining, which covers a full arch section and includes the floor, is being done by aid of the Webb-Cox type of concrete gun operated by compressed air.

In order to provide power for the construction work necessary in connection with this tunnel, a 30,000-volt transmission line was run from Power House No. 1, at Cascada. As a telephone line was considered too uncertain and too expensive to maintain in view of the emergencies that might arise and the severity of the prevailing winters, radio communication is resorted to exclusively between headquarters at Cascada and the Florence Lake camps. A local telephone service has been established between Camps 61, 62, and 63.



A bit of winter. Caterpillar tractors pushing their way through four feet of snow across the summit of Kaiser Pass.

As a means towards helping to keep the men on this isolated project satisfied, each camp has a recreation hall and a reading room, furnished with a phonograph, pool tables, magazines and books—the latter being supplied by the County Library. Once a week a moving picture is shown twice, the hours of the performances being so regulated that all shifts have an opportunity to see it.

At the time this article was written, the best monthly advance on a single heading had been made at Camp 60 during April, 1924, when 578 feet were driven in hard granite in 30 working days, or a daily average of 19.26 feet. The best rate of progress for all six headings was made during the week ending at 8 a. m. on April 26, when a total of 709 feet was driven. In this same week the heading at Camp 60 was advanced 150 feet or 21.4 feet per day, while the east heading at Camp 62 was pushed forward 152 feet. For the week ending April 5, the intake heading at Camp 63 went ahead 150 feet—all headings being in hard granite. These performances have since been improved upon.

In clearing the site for Florence Lake Reservoir, it was necessary to fell the equivalent of about 3,600,000 feet of merchantable timber; and in order to make use of this material there was erected at a convenient point a sawmill having a capacity of about 40,000 board feet of lumber per day. All trees 12 inches in diameter or over are there cut into lumber, which is backhauled to the numerous construction camps and used for a variety of purposes, such as the building of flow lines, of powerhouse additions, etc., as well as for the tunnel work, itself.

The tunnel heading at Camp 60 has progressed to a point underground almost three miles from the portal. This is also true of the west heading at Camp 61. To save time that would ordinarily be lost, dining-car trains for the tunnel crews have been employed for the past year. This service permits the men to have their midshift meal right at the heading, and takes up only about 15 minutes as compared with at least 1½ hours if the men are transported out to their meals and returned to the heading afterwards. These trains consist of five flat cars, on three of which tables and benches are fastened. The other two are equipped with suitable racks on which the provender is carried in army-type food containers from which it is served after the men are seated. This system has met with the heartiest approval on the part of the tunnel crews.

Had it been possible to follow a straight course between the inlet and the outlet portals, this tunnel—which is being driven in three sections—would actually have been two miles shorter than as it is now run. But, owing to the topography of the country, adits could not be driven between the intake and the outlet; and, furthermore, the overburden was found to be so great as to make it impracticable to sink shafts other than those described. Even so, the longer tunnel can be built in approximately two years less time than the shorter one, because the route chosen has made it feasible to carry on operations from two adits. In other words, tunneling is being actively pushed at six instead of two working faces.

When completed, Florence Lake Tunnel will drain a total area of 320 square miles and will deliver the water to Huntington Lake. Thence, after a drop of almost a mile, the water will be utilized by a succession of power houses. At Florence Lake, the bottom of the tunnel is at Elevation 7,220 while the outlet is at Elevation 7,000—allowing for a grade of approximately 3 feet per 1,000. At the point of intake there is to be built a dam, about 120 feet high, for the purpose of creating a storage basin that is to have a capacity of 60,000 acre-feet. This reservoir will submerge Florence Lake, from which the tunnel gets its name.

The total cost of the tunnel will be somewhere around $17,000,000; and, judging by the progress being made, it should be ready to convey the 1925 runoff of the south fork of the San Joaquin River into Huntington Lake. In short, the tunnel will be available for service one year sooner than the date set at the time construction was commenced.

Camp foreman Ed. McCabe and his crew who drove 152 feet of tunnel in one week in the east heading at Camp 62.

As the result of a survey made by a group of engineers of the port of Mazatlan, Mexico, a plan has been developed to construct there two breakwaters and a wharf large enough to take four ships of about 4,000 tons each. The proposed improvement is to cost something like $5,000,000.

ROCK-DRILL TROUBLES

By E. H. PAULL

CAREFUL and intelligent supervision and workmanship in both repair and blacksmith shops of drill users will prevent most drill troubles. Undoubtedly, a rock drill receives more hard, rough usage and less care than any other piece of machinery. This fact is not overlooked by the manufacturers; and, therefore, durability is one of the first considerations in the making of a drill.

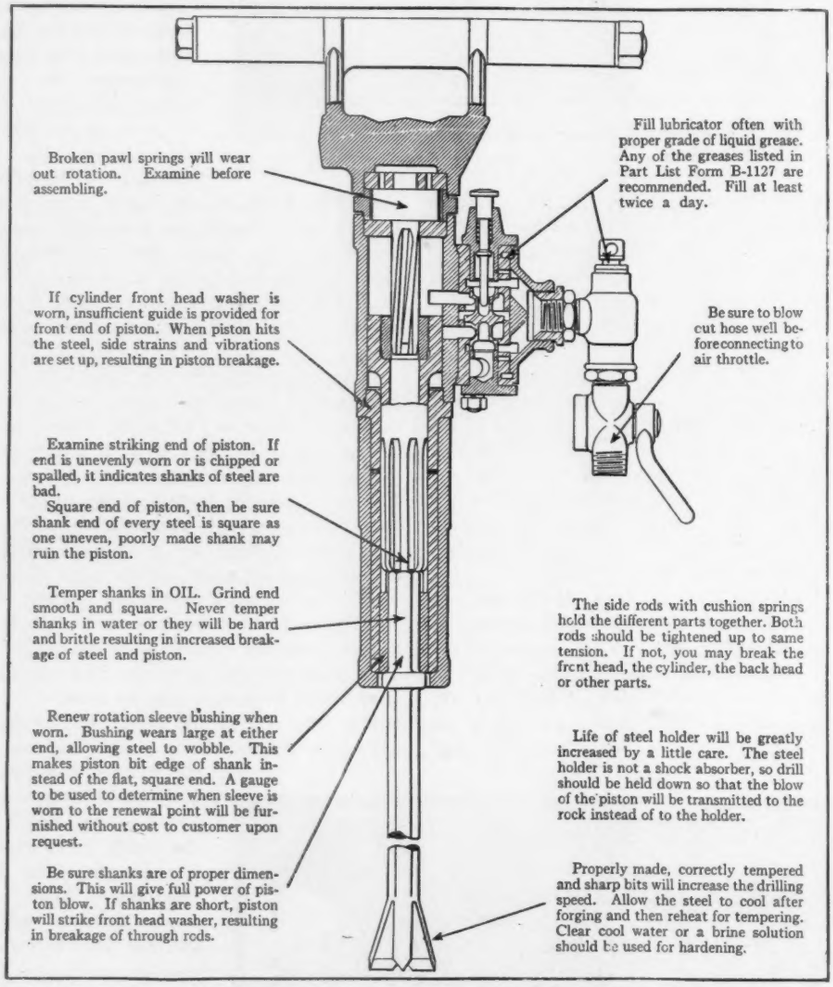
Like every other mechanism, a rock drill requires and is entitled to some attention, and when given this attention at the proper time and place it will operate efficiently and economically, even under the most severe conditions. Records from the "trouble department" of one of the largest rock-drill manufacturers show that 90 per cent. of all rock-drill troubles can be attributed to improper care and treatment in the operator's shops.

The trouble may be traced to the condition of the drill when sent back to the job or, as is true in most cases, to the drill steel. The state of the drill is not always a reflection on the repair man, however, for often the runner—unknown to and against the rules of most companies—will take a drill apart on the job, with the result that much dirt gets into the mechanism in its assemblage and that the side rods are pulled up unevenly. As a consequence, the parts are subjected to excessive wear, the efficiency of the machine is reduced, and through bolts are broken.

Very often a runner complains of loss of power and decrease of drilling speed. Apparently, the drill is working well enough, but the results are lacking. At once, the service man's attention is directed to the condition of the steel. If the bits are holding up and are of proper gage, the trouble can generally be found in the shanks: they may not be of proper length or the holes may not have been fully opened. However, if such is not the case, the trouble is looked for inside the drill. If the piston is badly cupped or short the power of the blow is not transmitted to the steel but is taken up by the through rods, springs, and front head.

A good deal of drill trouble, especially where hand sharpening of drill steels is practiced, can be traced to the size of the bits used. Usually the bits are too large, thereby cutting more rock than necessary, and are not of uniform gage. The lack of uniformity in gage causes rifled holes, excessive torque on the rotation parts, and a boring or reaming instead of a cutting action.

When all cuttings are not blown out of a hole, those remaining in it form a cushion, and thus the energy of a drill is expended in cutting and recutting those loose particles instead of in penetrating new rock with each blow of the hammer.


Broken pawl springs will wear out rotation. Examine before assembling.
Fill lubricator often with proper grade of liquid grease. Any of the greases listed in Part List Form B-1127 are recommended. Fill at least twice a day.
If cylinder front head washer is worn, insufficient guide is provided for front end of piston. When piston hits the steel, side strains and vibrations are set up, resulting in piston breakage.
Be sure to blow out hose well before connecting to air throttle.
Examine striking end of piston. If end is unevenly worn or is chipped or spalled, it indicates shanks of steel are bad.
Square end of piston, then be sure shank end of every steel is square as one uneven, poorly made shank may ruin the piston.
Temper shanks in OIL. Grind end smooth and square. Never temper shanks in water or they will be hard and brittle resulting in increased breakage of steel and piston.
The side rods with cushion springs hold the different parts together. Both rods should be tightened up to same tension. If not, you may break the front head, the cylinder, the back head or other parts.
Renew rotation sleeve bushing when worn. Bushing wears large at either end, allowing steel to wobble. This makes piston bit edge of shank instead of the flat, square end. A gauge to be used to determine when sleeve is worn to the renewal point will be furnished without cost to customer upon request.
Life of steel holder will be greatly increased by a little care. The steel holder is not a shock absorber, so drill should be held down so that the blow of the piston will be transmitted to the rock instead of to the holder.
Be sure shanks are of proper dimensions. This will give full power of piston blow. If shanks are short, piston will strike front head washer, resulting in breakage of through rods.
Properly made, correctly tempered and sharp bits will increase the drilling speed. Allow the steel to cool after forging and then reheat for tempering. Clear cool water or a brine solution should be used for hardening.

Typical instruction wall hanger published by one of the manufacturers of rock drills.

In order to secure the best service from rock drills, the following points are well worth remembering. And let it be remarked that the Ingersoll-Rand Company, one of the largest producers of rock drills, supplies without charge a wall hanger that diagrammatically points out what should be done to keep a drill fit for service. A photograph of one of these hangers is reproduced herewith. First off, it is essential to the efficiency and to the life of a drill that it be continuously lubricated. Concerted efforts are being made by rock-drill manufacturers to lay stress on the importance of lubrication and to introduce proper oiling methods. Many operators rely on the all-too-prevalent practice of lubricating through the inlet hose. It should be discouraged, as it is not dependable and does not feed a continuous supply of oil to all parts of the drill. However, if lubricated often enough in this way, say every few minutes, the method is fairly satisfactory. But, unfortunately, it is the custom to introduce a few spoonfuls of grease when the hose is connected to the drill; to run the machine until it ceases to operate, simply because of a lack of oil; and then to put in more grease. This is an extremely bad procedure.

As a guard against this practice the manufacturer of rock drills has perfected an air line lubricator. This small, foolproof device is reliable and dependable under all conditions and assures a constant supply of liquid grease to all working parts of the drill. It is a safeguard against any possible chance of the drill running dry should the regular pockets and lubricators become empty through neglect to refill. One filling of the air line lubricator will afford continuous lubrication for one rock drill during a single shift.

The lubricators and the grease pockets as provided are ample to continuously lubricate all parts of a drill if those pockets are kept filled with the proper grade of lubricant, as recommended by the manufacturer. It is good practice to fill the grease pockets twice each shift, as it guards against wear, increases the drilling speed, and also adds to the life of the machine.

Drill steels should be of the best quality so that they will be equal to long and hard usage. See that the shanks and bits are properly made and of correct dimensions, and that the steels are given the right heat treatment. More good drill steel is condemned and discarded because of careless, inaccurate heat treating than for any other reason. The proper method of heat treating any grade of drill steel can always be learned from the manufacturer.

Be certain that your air supply is plentiful, and that the pressure at the drill is sufficient to operate it to the best advantage. As insufficient pressure lowers the drilling speed, an examination of the air line may prevent much trouble in this respect.

It is worth while, even when a drill seems to be giving the best of service, to dismember it occasionally and to clean the parts. They should be washed well with kerosene, examined carefully for wear, and then oiled and reassembled. Most drill makers furnish limit gages which indicate when a part is worn to a point calling for replacement.

Electro-Pneumatic System Guides Dense Railway Traffic

THE Oakland Pier Tower of the Southern Pacific Railroad directs, so it is said, a greater volume of train traffic than any other signal-and-switch tower in the western part of the United States. This important work is handled by eight men aided by a supervising towerman.

As might easily be imagined, the duties at this California terminal are exacting and call for so much skill and knowledge that but few substitutes can be found capable of taking the places of the regular towermen. During the morning and the evening rush periods, three operators manipulate the apparatus, and a fourth handles the orders received over the three telephones that enter the tower. For the rest of the day and the night the shifts are divided among eight towermen.

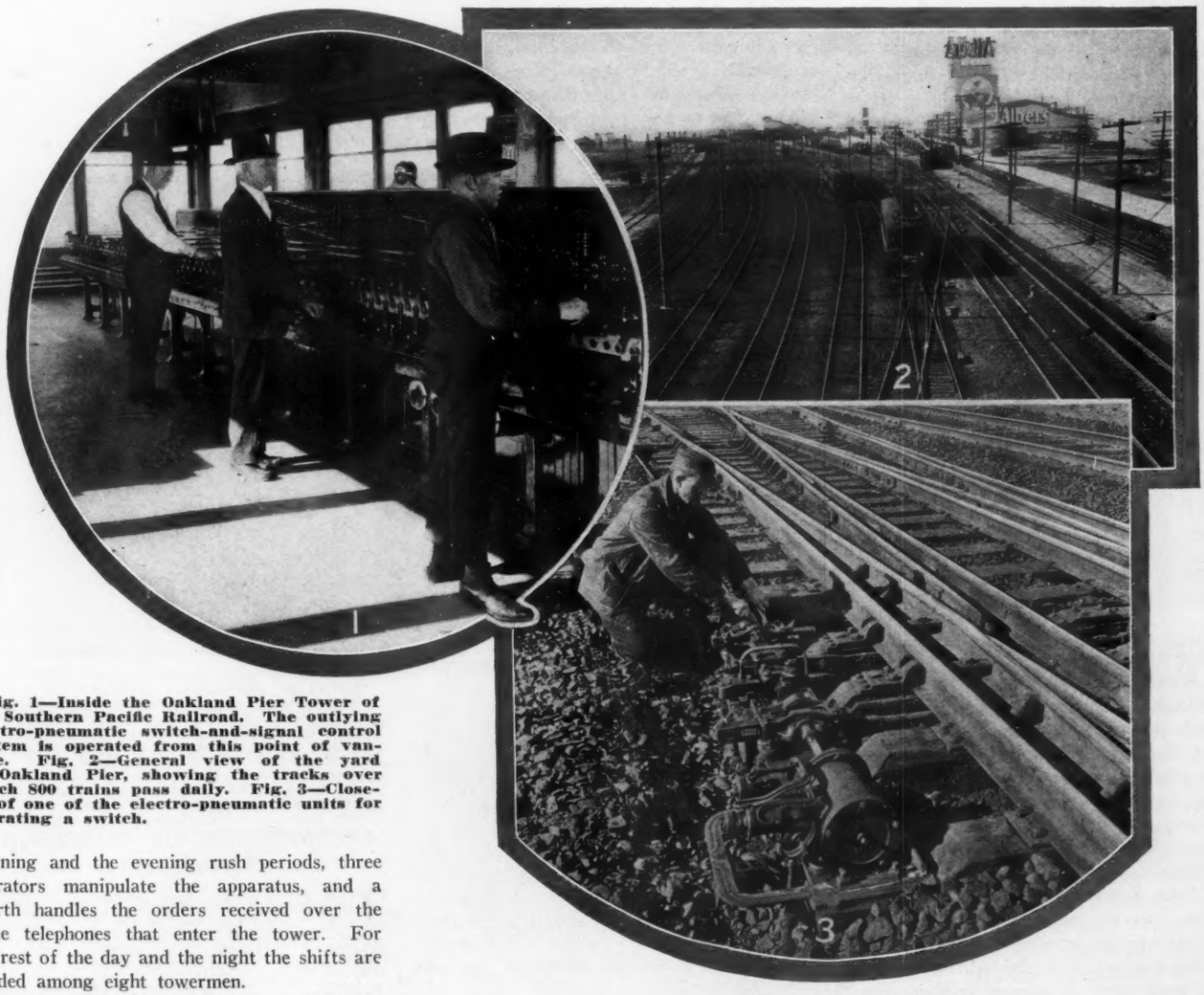


Fig. 1—Inside the Oakland Pier Tower of the Southern Pacific Railroad. The outlying electro-pneumatic switch-and-signal control system is operated from this point of vantage. Fig. 2—General view of the yard at Oakland Pier, showing the tracks over which 800 trains pass daily. Fig. 3—Close-up of one of the electro-pneumatic units for operating a switch.

The system installed by the Southern Pacific has been devised to safeguard the lives of passengers while speeding to and from their daily tasks or pleasures; and it functions so smoothly that the hastening traveler is more often than otherwise quite unmindful of its part in the control of the movement of his train.

From the tower are manipulated all the switches and signals within the terminal district extending for nearly a mile eastward; and these switches and signals regulate the progress of 800 trains every 24 hours as they journey in and out of the sheds. More than 20,000,000 people pass through the Oakland Pier Station annually; and in the course of a single day the tower guides no fewer than 2,200 train movements.

Compressed air and electricity are the motive mediums relied upon to actuate the interlocking switch-and-signal plant. Electricity, through suitable contacts and magnets, opens and closes the proper valve at a switch or signal so that compressed air can complete the desired movement. To be specific, the installation takes care of traffic on ten parallel tracks feeding into twenty tracks which flank the numerous platforms of the terminal sheds.

Primary control of this electro-pneumatic equipment is exercised by a machine placed in the tower. This apparatus is 33 feet long and 6 feet wide, and above it is a model board displaying on a reduced scale the essential features of the outlying yard. Thereon are indicated each line of track, each signal, and each switch; and when a signal or switch is moved this action is shown in a suitable manner by a tiny lamp at a corresponding point on the board.

Along the front edge of the machine are two rows of levers. The top row, 65 in number, governs the switches, while the lower row, containing 54 levers, has to do with the signals. Below the levers there is an offset row of small squares of glass upon each of which is painted a numeral in agreement with the associate switch. When a switch is occupied by a train, the light beneath the glass is out, but when the switch is clear the little incandescent bulb burns.

Above the machine and suspended from the ceiling is another board. At one end nothing is visible save what might be mistaken for a miniature shooting gallery having five targets with white countersunk bull's-eyes. To the left is a long series of diminutive signal posts and semaphores. All these have a service to perform in this directing center of traffic. When a train approaches the pier, one of the five

bull's-eyes is automatically covered by a red disc which falls into position, thereby indicating that the train is within the limits controlled by the Oakland Pier Tower.

As a train proceeds along the pier toward the shed, the indicator board, by means of the little semaphores, repeats the exact operation of the corresponding signals out in the yard, and thus discloses the changing position of the train. In a kindred fashion, the little lights under the switch levers tell their story to the towerman—disappearing while a train is passing over a switch and shining brightly when the track is clear.

FLY-POWER INSTEAD OF HORSE-POWER

PERHAPS THE most wonderful feature of the radio transmission of speech is the extreme weakness of the energy actually required for the operation. This, among other things, is strikingly brought out in a paper read by E. W. Rice, Honorable Chairman of the Board of Directors of the General Electric Company, before the World Power Conference in London.

"It has been stated," Mr. Rice said, "that perhaps the most minute electrical energy is that which enters a wireless receiving set when receiving an announcement from some remote territory. It is so small that it is difficult to give its magnitude any significance. It could be expressed in milliwatts; but Doctor Whitney has suggested that we could properly think of it in 'fly-power,' as contrasted with horse-power; and he has calculated that one inch of fly-power—the power exerted by a fly in lifting itself an inch—would operate a wireless receiving set for over a quarter of a century. This energy, when amplified by our electron vacuum tubes, is sufficient to be heard in the telephone headpiece or through the medium of a loud speaker over a large area."

BAUXITE IN DEMAND TO MAKE CAST CEMENT

INCREASING interest in bauxite developments is shown by French manufacturers, because of their confidence that cast cement will soon be produced at a price allowing its wide industrial use. In making this product, bauxite is necessary; and if its manufacture by the rotary furnace can be perfected, as aluminum interests believe it can, its output will grow apace. Such an accomplishment would greatly reduce the price of cast cement, and put it on a basis with existing brands.

The new product, it is claimed, has a wide field of application, because it remains unchanged in the presence of waters charged with acids and magnesia. A number of cement interests, therefore, have been added to the list of those anxious to acquire bauxite deposits.

The consumption of bauxite, due to the prosperity prevailing in the aluminum industry, has risen beyond all previous records. Statistics show that during the first ten months of 1923 there were mined in France 270,000 tons of this mineral. In 1924, the production and deliveries have continued regular and at a high figure.

NEW PORTABLE MINE-CAR AIR COMPRESSOR

A MARKED ADVANCE in portable equipment for underground mining, and one in which coal-mine operators, particularly, are showing considerable interest, has been made in the newly designed, Type Twenty, mine-car air compressor recently placed on the market by the Ingersoll-Rand Company.

Before enumerating the outstanding features of this type, let us consider briefly some of the steps in the development of the air compressor. The first compressors of which we have knowledge—apart from bellows—were hydro-compressors, and these were dependent for their operation on falling water.

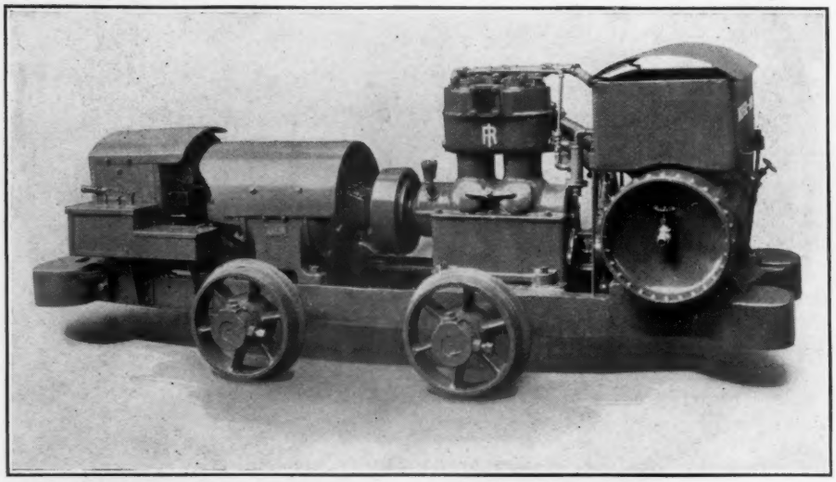
The first mechanical air compressors, which were placed on the market within the memory of the present generation, were huge, slow-speed, low-capacity machines, expensive to build and equally expensive to run. They were very heavy, needed a lot of floor space, and had to be supported by a massive foundation to assure alignment. By comparison, subsequent stationary units were of much lighter weight, of higher speed and of greater capacity. Furthermore, they required less floor space; and a simple foundation sufficed to assure their alignment.

With the gradual improvement of the air compressor, its value to industry increased; and it was inevitable that there should arise a demand for a portable machine—one that could be moved easily and quickly from place to place and that would always be ready for service. The usefulness of compressors of this type need not be elaborated here.

Portable mine car compressors are nothing new; but, appreciating the exacting nature of the work, the company in question set itself the task of carefully studying the conditions under which machines of this sort have to operate and then of designing equipment that would best meet those requirements. The new Type Twenty, electrically driven, mine-car air compressor is the result. Its structural details need not be gone into here; but it should be of interest to learn something about its advantages as demonstrated by tests made under actual service conditions in the Pennsylvania coal fields.

No blocking up is necessary; the car operates with less vibration when on the track than preceding machines of this sort even when blocked up. As compared with earlier types, it is more compact, that is, it is approximately 1,000 pounds lighter for a given capacity. It delivers not only 20 per cent. more air per dollar, of first cost, but likewise furnishes more air per dollar spent for power and maintenance.

The compressor is of the vertical, duplex type. Its natural tendency to vibrate is along the vertical plane, and this has been counteracted by centering the compressor over one of the axles—giving it, in effect, a solid foundation. The electric motor, which is of extra-heavy construction and built to resist vibration, is connected to the compressor by means of a quickly detachable coupling. The whole equipment is mounted on a rigid, cast-steel frame, to the underside of which are attached mine-car wheels on short centers to permit taking sharp curves.



The mine-car compressor obviates the use of long pipe lines and delivers the desired air from a point close to the scene of operations.

This self-contained mine-car compressor is being manufactured in three sizes, namely: 91, 160, and 230 cubic feet per minute piston displacement.

COMPARISON OF COAL-MINE FATALITIES

THERE is a persistent impression both here and abroad that the record of accidents in American collieries is deplorably worse than that of other countries, but the facts do not altogether warrant this. The Labor Bureau of the League of Nations has published a list of the number of men killed in mining accidents in five of the leading nations for the twelve years from 1911 to 1922; and, in relation to the tonnage of coal, brought to the surface, the United States shows up best of all. The fatalities per 1,000,000 tons of coal mined average as follows: United States, 4.27; Great Britain, 4.66; France, 5.95; Belgium, 6.65; and Prussia, 9.85. Figures of this kind are not, strictly speaking, comparable because conditions are far from identical.

An Interesting Example of High-and-Low Pressure Gas Distribution

The St. Louis County Gas Company Has Effectually and Economically Solved an Unusual Service Problem

By O. R. ALLGEIER*

JUST about 21 years ago, the St. Louis County Gas Company was incorporated, and the first gas mains were laid in St. Louis County, outside the city limits of St. Louis, Mo. Gas was purchased from the Laclede Gas Light Company of St. Louis, and was fed directly into the main system at low pressure. In 1905, a compressing plant was installed in near-by Maplewood, and the construction of a high-pressure system was begun. This system was extended to serve the suburban towns of Webster Groves and Kirkwood, and gas was supplied the pumping plant from the mains of the Laclede Company.

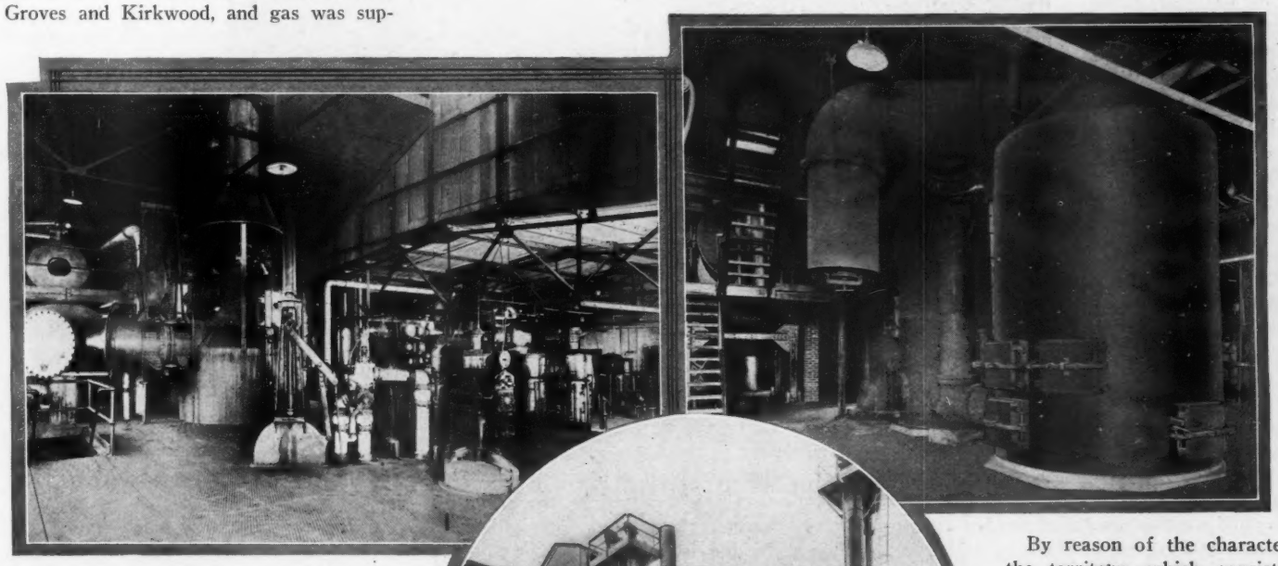


Fig. 1—Operating floor of generator building where are installed three water-gas sets which obtain the needful steam from waste-heat boilers. Fig. 2—Close-up of 10-foot water-gas set in the generator room, with waste-heat boiler at the extreme left in the rear. Fig. 3—Exterior of generator building. Here are seen the 10-foot condenser for cooling the illuminating gas and the 30-inch, welded-steel gas header.

This service sufficed for a while; but, with the rapid growth of the suburban communities in St. Louis County, it was soon deemed advisable to erect a gas works so that the company could supply the greater demands of its territory. Accordingly, in 1911, the construction of a complete water-gas generating plant and compressing plant was begun. In the following year, the present company—The St. Louis County Gas Company—was organized and took over the business of the original concern.

The expansion of the company's business has been continuous and rapid. In one year only, namely that of 1919, did the gas sales fall below those of the preceding year; and, even then, the decrease was due not to a cut in the number of customers but to a reduction in the consumption of gas per customer following the close of the war. An accompanying table shows the growth of business from 1912 to 1923, inclusive; and therefrom it can be seen that the number of customers has practically tripled and that the gas sales have more than tripled in the twelve years recorded.

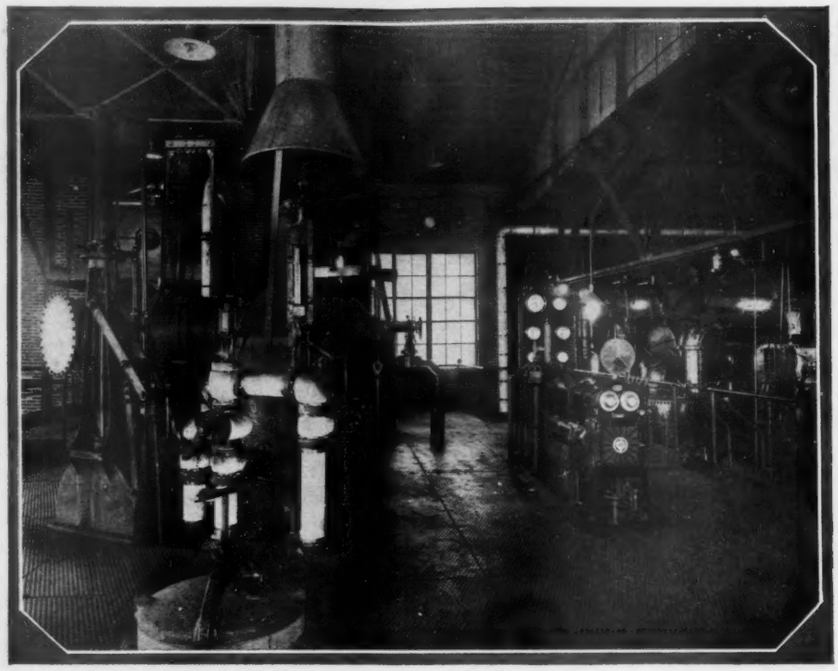
The region served by The St. Louis County Gas Company nominally covers all of St. Louis County which, as a territorial subdivision of the State of Missouri, is distinct from the City of St. Louis. The distributing system, however, covers only that portion of the county where the growth in population has economically justified supplying gas, and includes ten incorporated cities and seven unincorporated communities. The incorporated cities are: Kirkwood, Glendale, Webster Groves, Shrewsbury, Maplewood, Brentwood, Richmond Heights, Clayton, University City and Ferguson, while the unincorporated communities, which have all the attributes of small towns, are: Luxemburg, Hanover Heights, Wellston, Vinita Park, Overland Park, Pine Lawn, and Jennings. The number of inhabitants of each of these places varies from 1,500 to 20,000; and their total population is approximately 110,000.

By reason of the character of the territory, which consists of suburban districts surrounding a large city, the service demands upon The St. Louis County Gas Company are distinctly different from those usually made upon plants of the same size. Substantially all its load is for residential consumption, there being but relatively few customers who use gas for industrial purposes.

Year	Gas sold cubic feet	Customers at end of year	Increase in customers
1912...	174,805,000	6,484	....
1913...	203,928,000	7,731	247
1914...	231,463,000	8,320	589
1915...	250,452,000	9,052	732
1916...	274,878,000	10,024	972
1917...	331,683,000	10,729	695
1918...	351,194,000	11,262	543
1919...	350,869,000	12,298	1,036
1920...	411,064,000	13,569	1,271
1921...	414,599,000	14,790	1,231
1922...	476,504,000	16,789	1,999
1923...	562,073,000	19,171	2,382

*Engineer, The St. Louis County Gas Company.

While that portion immediately adjacent to St. Louis is densely built up with apartments and detached dwellings, the outlying districts are only partly developed, so that the average number of customers per mile of main is comparatively small—about 60 at the present time. In the development of a suburban region, such as described, it is not always possible to foresee clearly just what direction home building will take, or to what limits it will go, because no fixed boundaries and no definite zones are established. It is difficult to plan a system of gas distribution where development depends in large measure upon the vagaries of the real-estate promoter and the home builder; but the employment of a combination high-and-low-pressure system has solved this problem most satisfactorily.



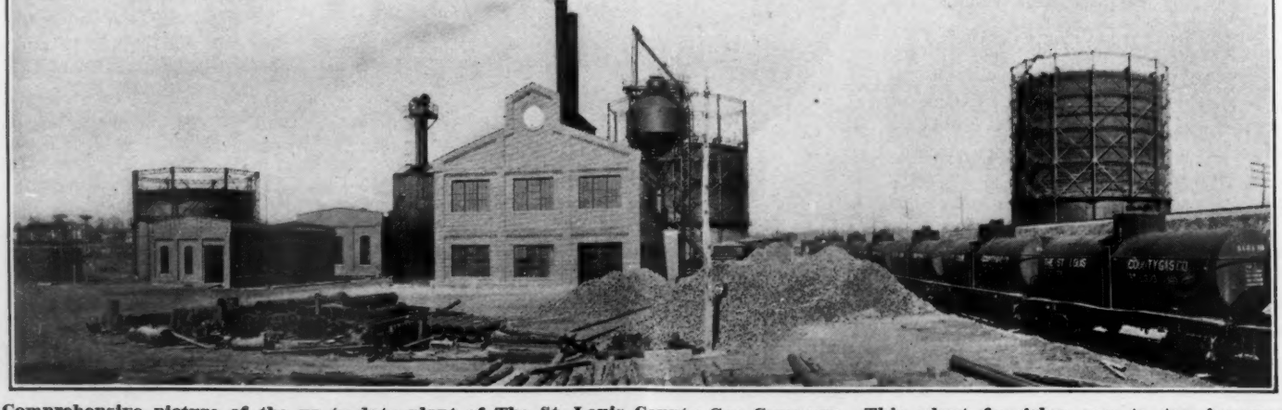
Operating floor of generator room, giving a near view of the 10-foot water-gas set and the automatic controls.

Owing to its proximity to the city and to good roads for automobile traffic, many successful business men of St. Louis have reared permanent homes in St. Louis County. As a general rule, these are residences in the true sense of the word; and while they usually have spacious grounds that tend to keep down the number of customers per mile of main, this is somewhat offset by the large consumption of gas per customer. However, people of means are not the only ones who have chosen to live in these suburbs, as indicated by the rapid construction during the last two or three years of moderate-sized houses and bungalows on most of the vacant property in the communities. This is rapidly increasing the number of customers per mile of gas main; and the indications are that in a few more years many of the suburbs will be almost solidly built up with a better class of homes than that ordinarily found in territories having approximately the same population.

In order to supply the load on this far-flung distributing system, the company in question operates only one gas plant, known as the Shrewsbury Works. But it has been necessary from time to time to provide greater manufacturing capacity as the demand for gas has grown. This was done in 1918, when the output of the plant was increased approximately 50 per cent. by raising the pressure of the air blast supplied to the water-gas generating machines. Then, the original steam-driven blowing equipment was replaced by more modern electric blowers. Two years later, this was followed by the installation of a waste-heat boiler, designed to generate steam from the heat in the gases as they come from the water-gas machines, and which is ordinarily dissipated. This boiler made more economical operation possible; and further economies were realized by purchasing central-station electric power to drive all the machinery except that portion which could be run by excess steam, from the waste-heat boiler, not required for gas generation. With this arrangement it was virtually practicable to shut down the coal-fired steam boilers, thus effecting a considerable saving in fuel and boiler-room labor.

In 1922, it became apparent that more gas would be necessary by the fall of the succeeding year. Accordingly, early in 1923, work was started on the installation of new water-gas and gas-compressing machinery, which substantially doubled the manufacturing and pumping capacity of the works. Including the latter equipment, the water-gas generating machinery consists of two 7½-foot U. G. I. water-gas sets with manual controls, provided in 1911, and one 10-foot U. G. I. water-gas set with automatic controls, put in service in 1923. In connection with the 7½-foot sets there is a duplex U. G. I. waste-heat boiler, installed in 1920, which can be operated with either set—not with both, simultaneously. The 10-foot water-gas set also has a duplex waste-heat boiler which, at present, can be used only with that particular set. However, the latter boiler is so arranged that it can be worked with a future 10-foot or 11-foot set, for which room has been provided in the new generator house.

The blowing equipment of The St. Louis County Gas Company's plant which furnishes the air blast for the water-gas sets consists of four Buffalo Forge, steel-plate blowers: two 72-inch and one 90-inch, with motor drive, and one 60-inch blower, run by a Terry steam turbine. The latter serves as a reserve unit, and is operated only in case of failure of the electric



Comprehensive picture of the up-to-date plant of The St. Louis County Gas Company. This plant furnishes gas to ten incorporated cities and to seven unincorporated communities embracing a total population of approximately 110,000.

supply. These blowers provide air at a pressure of 30 inches to the older sets and at 42 inches to the new set.

The five gas take-off pipes, one from each of the wash boxes of the three gas machines and from each of the wash boxes of the two waste-heat boilers, are manifolded to a 30-inch welded steel header located outside the generator house. Interposed between this header and the 50,000 cubic-foot relief holder is a 10-foot, 4-pass, vertical tubular condenser for cooling the illuminating gases as they leave the sets.

Two 13-cubic-foot Connersville exhausters and one No. 8½ Root exhauster are used to discharge the gas from the relief holder and to force it through secondary condensers, P. & A. tar extractors, two 8-foot shaving scrubbers, four 24-foot outdoor cylindrical steel purifiers, and station meters into the storage holders. Two station meters are in service—one a 10-foot Hinman drum meter and the other a Thomas meter having a capacity of 150,000 cubic feet per hour. There are two storage holders: one capable of storing 500,000 and the other 1,000,000 cubic feet of gas.

Coke is used exclusively for generator fuel in the Shrewsbury Works. When the plant was enlarged in 1923, coke-handling equipment was deemed necessary, and was then provided. This included a concrete track hopper into which the fuel is dumped from railway cars. An automatic skip hoist, with a 40-cubic-foot bucket, delivers the coke continuously to an 80-ton, conical, steel bunker above the generator-house operating floor. From this bunker the coke passes by gravity over bar screens to the operating floor of either the 7½-foot sets or the 10-foot set.

For enriching the water gas to the proper heat value, in compliance with state regulations, 32-36 gravity Mid-Continent gas oil is used. This is received in tank cars and handled by gravity and pumps to and from storage tanks in the plant yard. During the war, in order to insure an adequate supply, the company found it necessary to purchase tank cars to transport the oil needed. Water for steam and cooling purposes is pumped from a pond, on the plant site, which is fed by springs.

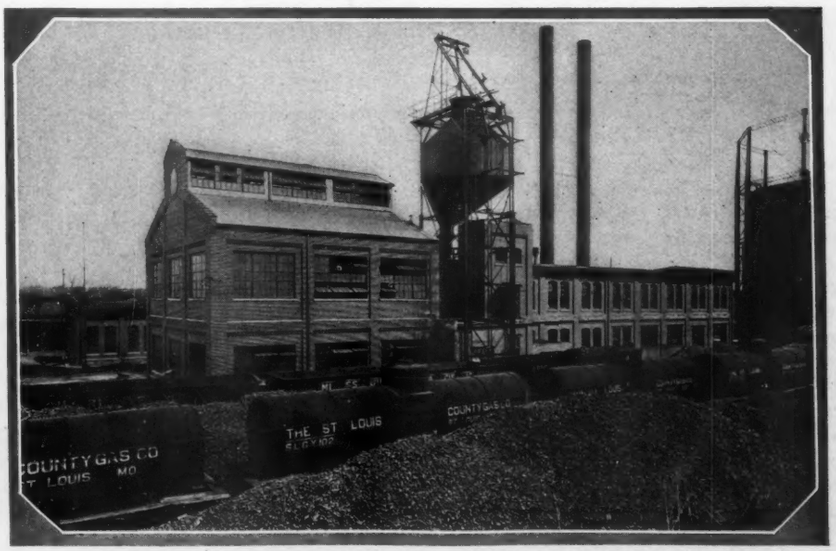
Concrete dam at water supply pond. From this pond water is drawn for steam raising and condensing purposes within the plant. On the trestle surmounting the dam run two 8-inch, high-pressure pipes forming part of the gas distribution system.

As nearly 90 per cent. of the gas made in the Shrewsbury Works is sent out at high pressure, it is necessary to have dependable compression equipment. When the plant was built in 1911, two 17¾&17¾x18-inch, Class "O," Ingersoll-Rand compressors were installed. These machines are now driven by compound, non-condensing steam engines. In 1920, one of them was converted to electric drive, and, in keeping with the growth of the establishment, a 16 & 16x14-inch Imperial Type, XB, electric-driven compressor was added. These changes provided the necessary compression equipment until 1923, when a 19½&19½x16-inch, Class PRE-1 compressor was installed and the electric-driven, Class "O" unit was reconverted to steam drive. With this arrangement of steam and electric-driven compressors, the plant is able to take care of the present-day load under any conditions that might arise. All the compressors are manifolded to a common suction and a common discharge line. No after-cooler is in use, although some consideration is being given this matter with a view to removing the condensable vapors before the gas gets into the distributing system.

All compressors, except the Class PRE-1 unit, are started under load with the suction and discharge valves open. As the latter machine, being synchronous-motor driven, cannot be started under load, a 10-inch bypass is utilized and the load applied after the unit is up to speed. Separate, direct-current excitation for running the synchronous motor is provided by a motor-generator set placed outside the engine-room, where there will be no danger from a sparking commutator.

None of the compressors is operated automatically. The present system of operation is to allow one of the Class "O" steam-driven machines to float on the line—utilizing excess steam generated by any of the waste-heat boilers. As the load demands, the electric-driven compressors are cut in and out—keeping the outgoing-line pressure at a prescribed amount.

The feature of this plant that should be of special interest to gas engineers is the use of waste-heat boilers in conjunction with electric power. When the first waste-heat boiler was put in service in the plant of The St. Louis County Gas Company in 1920, a study was made to learn just what could be expected of this type of boiler as a steam producer. It was found that it could be counted on to produce enough steam to operate the water-gas set, the exhauster engines, the boiler feed pumps, the oil pump, and the pumps supplying water to the hydraulic valves of the sets. Accordingly, all other machines, including pumps, excepting stand-bys, were electrically operated or changed over to electric drive. Warm water from the gas condensers was used for boiler feed; and there was just sufficient exhaust steam from the steam-driven machines to heat this water in the feed-water heater to the proper temperature. As a result, little heat was lost; and the coal-fired boiler equipment was



Generator house. Here we see the overhead, steel bunker rising above the building and the coke storage yard of the plant.

virtually shut down except in cases of emergency and when heating the buildings, holders, and purifiers.

When the 10-foot water-gas set and the waste-heat boiler were installed in 1923, the same general system was adopted. However, with the larger set, the boiler generates more steam than is required for the water-gas set, exhauster engine, feed-water pump, oil pump, and hydraulic pump. To utilize this excess steam, one of the steam-driven compressors is allowed to float on the line.

Electric current for the Shrewsbury Works, which is purchased, is of 3 phase and is delivered at a pressure of 13,200 volts. This is stepped down to 440 volts for use throughout the plant. By owning the transformer station and by buying power in large blocks, metered at high tension, the company is able to get current from the local electric station at an advantageous rate.

In the more densely populated portions of the territory, near the limits of the City of St. Louis, the system is low pressure and is made up of 4, 6, 10, 16, and 20-inch cast-iron mains. In the outer belt, or more sparsely settled region, the system is high pressure; gas being pumped at a maximum pressure of about 28 pounds per square-inch gage. Wrought-iron and steel mains, ranging from 1¼ to 8 inches in diameter, compose the high-pressure system.

At the beginning of the current year, there were in service 78.8 miles of low-pressure mains of all sizes and 234 miles of high-pressure mains, while 507,997 feet of piping conveyed gas to the low-pressure customers and 764,020 feet to those on the high-pressure system—making a total of 1,272,017 feet of service mains. About half the customers are furnished with gas from the high-pressure system through individual house governors, while those remaining are served directly from the low-pressure system. Gas is fed to the low-pressure system from the storage holders through a station governor and, at six points in the system, from the high-pressure mains through district regulators. As a high-pressure main belts the outer boundary of the low-pressure system, it is possible to feed gas into the low-pressure line at any desired point.

This combination distributing system has several valuable features which may be worth mentioning. First, advantage is taken of the long life of cast-iron piping in the more congested districts, where the streets are nearly all paved; second, in the sparsely settled regions, where customers per mile are few, the investment in mains is kept low by using steel and wrought-iron pipe of comparatively small diameters; and, third, operating and investment costs are very notably lowered by having a central storage and pumping plant instead of auxiliary storage holders and booster stations at various points along the system. The merits of the dual high-and-low pressure system will be more appreciated when it is realized that an area of approximately 67 square miles is covered by the mains; that the most distant customers are about 14 miles from the gas works; and that a low-pressure network of comparatively small piping, terminating seven miles away from the central plant, is operated continuously from the gas-works holders without auxiliary holders or boosters other than the district regulators.

At each low point in the distributing system a drip is provided for collecting liquid condensate, which is carried by the gas or vapor and deposited in the mains as the temperature of the gas decreases. In the low-pressure mains, a cast-iron line pot is used to collect this condensate, known as "drip oil," while the high-pressure mains have a log drip for the purpose, which consists of a pipe cylinder of suitable size and length. Low-pressure drips are pumped while high-pressure drips are blown at regular intervals into a tank mounted on a truck. At the works, the oil is separated from this condensate and sold. From this oil, among other things, benzol is recovered and used as a motor fuel.

The compressors in the Shrewsbury Works of The St. Louis County Gas Company supply air for various purposes besides compressing gas to render its distribution economical. Compressed air is the best motive power for cleaning waste-heat boiler tubes and is, therefore, employed for that service in the plant in question. These tubes, as is well known, become coated inside with a hard carbon deposit from the gases. The high speed and the great power of the air-driven cleaners make them especially suited for the rapid and efficient removal of this substance.

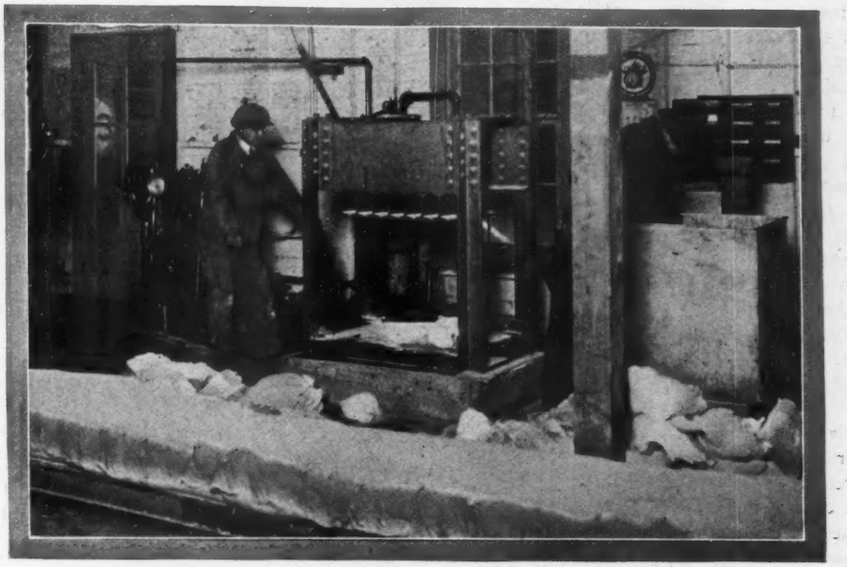
Air is piped throughout the plant and is used for blowing dust out of machines, for operating "Jackhamers" employed on the premises for construction work, and for driving pneumatic tools when calking lead joints in cast-iron pipe. The importance of compressed air for some of these services is best exemplified by calling attention to the storage holders in the the accompanying illustration. The many metal sheets, making up the great envelopes of these gas holders, are riveted and calked by means of compressed air.

General plan of territory served by The St. Louis County Gas Company.

Disk-Spray Process Revolutionizes Rubber Industry

By A. M. HOFFMANN

THE romance of rubber—and the story of rubber is, indeed, a romantic one—has no more illuminating page than that which records the recent development of what is known to the trade as the sprayed-rubber process. The evolution of that process is a technical achievement that marks an abrupt turn in the long road over which manufacturers have traveled for many years in their efforts to improve upon the crude method employed by the primitive natives of tropical Brazil to effect the coagulation of latex.



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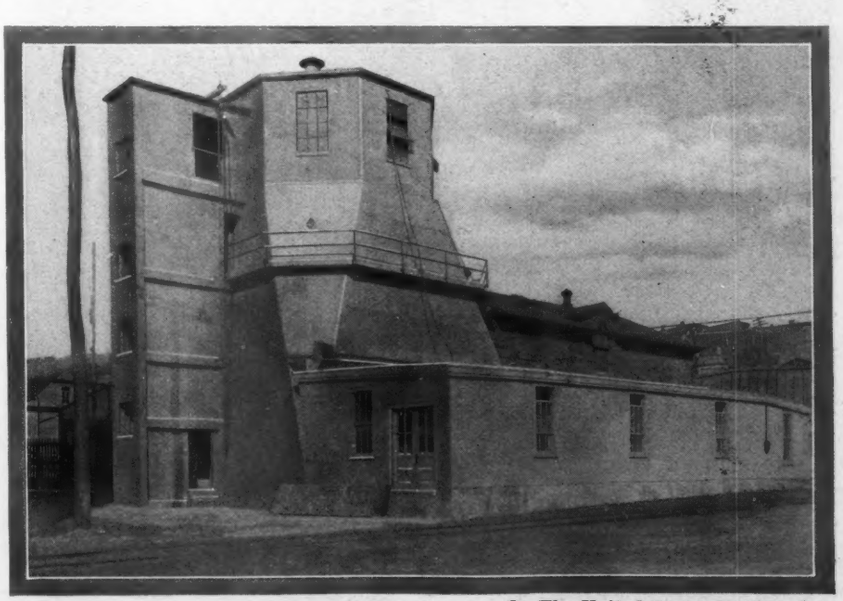
How the rubber looks during one of the stages of its manufacture.

For the sake of those that may not be familiar with the nature of latex, let it be said that it is a white liquid which exudes from a rubber tree whenever the outer bark is cut. This juice is not the sustaining and structure-building sap of the tree but, instead, a fluid which Nature seemingly has provided to cure the superficial wounds of the *Hevea,* as the botanist classifies the rubber tree.

In the jungles of Brazil it was the custom of the forest-ranging natives to solidify the latex by dipping paddles in the liquid and then exposing the wet surfaces to the hot and dense smoke produced by burning *uricuri* nuts. Thus, layer after layer was built up, and when the accumulation reached a suitable stage the mass was split and the paddle withdrawn. Unfortunately, the acrid smoke of the nuts filled the rubber with soot, discolored the substance, and materially altered some of the desirable properties of the rubber. Even so, the procedure served to preserve the latex before it could sour and spoil and made it possible to send the crude rubber to distant countries where it could be held in storage until the manufacturers were ready to work it into many kinds of commodities.

In endeavoring to provide a more desirable grade of crude rubber, chemists found that the latex could be coagulated at the rubber plantations by mixing with it certain chemicals just after the juice was tapped from the trees. This was a decided improvement upon the curing method practiced by the natives who worked in the jungle and dealt with the latex of the so-called wild rubber tree instead of with the cultivated growth of present-day plantations. But the chemical process of coagulation has its drawbacks: the physical qualities of the rubber are more or less impaired by it, and the product is decidedly variable in its essential characteristics. The object of continued research was to find a way by which pure rubber could be obtained, for it was realized that rubber of this sort would possess greater tensile strength, that it would be better able to resist wear, and, in short, would be greatly superior to that generally marketed. These desired ends have been reached after a great deal of experimenting upon the part of laboratory workers and other associate technicists. The outcome is due to the devising and the perfecting of the sprayed-rubber process, which has been actively employed on a commercial scale for a year and more.

While much of the crude sprayed rubber now brought into the country is treated in plants built for this purpose on or near the rubber plantations in the Far East, still an increasing amount of latex is shipped to the United States from Sumatra and the Malay Peninsula for preparation by the spraying process here within our own gates. In order to preserve the latex in transit, the fluid has mixed with it a suitable percentage of ammonia; and this keeps the latex sweet and does not impair the raw material the while. It is interesting to learn that no fewer than four steamship lines are today bringing latex to the United States from distant Asia. This is the outcome of a number of experimental voyages—during which various containers were utilized—which finally disclosed that the latex could be carried in the oil or the ballast tanks of a vessel provided those compartments were properly cleansed beforehand. Tank cars are employed to convey the latex to the seaboard and, later, to move the fluid from the



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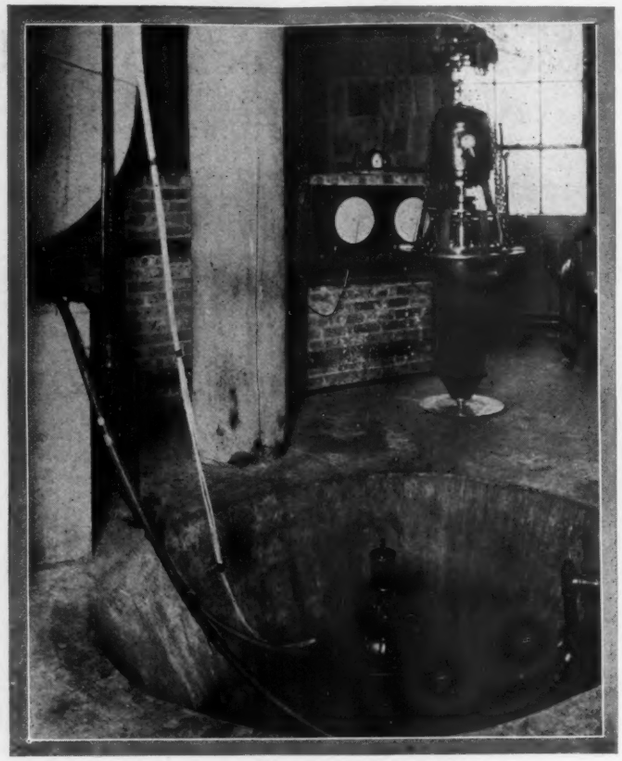
One of the new plants where rubber is now being manufactured from latex by the so-called "spray process."

incoming steamer to the plant or plants where the liquid is converted into sheets or blocks of rubber from which rubber articles or commodities are afterwards produced.

Before describing the disk-spray process, it might be mentioned that the previously prevailing method of effecting the coagulation of the latex consisted in pouring the milky fluid into a vat or pan and then adding the necessary chemicals. This procedure caused the rubber molecules to solidify and, in a short while, to unite and to form a white, plastic mass. This mass was then withdrawn from the surrounding liquid and run through rollers for the purpose of pressing out the remaining moisture. This method is not an economical one, because it fails to extract all the rubber in the latex, and its use, therefore, involves a loss of considerable valuable material.

One of the essential features of a plant equipped to produce rubber by the new system is a concrete tower having an upper and a lower chamber. In the upper room are placed latex tanks, an air-heating furnace, and means by which the hot air can be forced down and into the lower room at a suitable pressure through a number of pipes of proper size. In the floor of the upper chamber there is a large, hemispherical basin or cavity opening into the chamber beneath, and in the center of this well is suspended a motor-driven shaft having at its lower end a sizable, metal disk. Surrounding this shaft is a cylindrical envelope or tank into which the latex is fed and from which it flows onto the disk. The flow of the latex can be regulated to a nicety; and the disk, when in working position, projects through an opening in the bottom of the well and into the chamber beneath, where it hangs a few inches below the ceiling.

The drying chamber, for such is the lower compartment, is a concrete-walled room 30 feet square and 30 feet high. Upon the concrete floor is arranged a movable floor consisting of parallel sections mounted on rollers, and these sections can be shoved out of the drying room, one at a time, so that the sheets or slabs of rubber formed on them can be conveyed to an adjacent part of the plant in which are installed hydraulic presses.



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Interior of the upper room of the sprayed-rubber plant, showing an electrically driven rotor in position in the hemispherical pit. Another rotor, with an attached disk, is suspended from the overhead runway.

When all is ready, electric current is fed to the surmounting motor, the metal disk is revolved at a high rate of speed, and the latex is fed upon the whirling plate by means of compressed air. The action of the spinning disk atomizes the stream of descending latex, and this mist is caught by the downward currents of hot air which vaporize the moisture in the latex and cause the minute particles of rubber to fall to the floor where they coalesce. Gradually, there is thus built up a layer of spongy rubber; and when this has attained a suitable thickness the floor sections are removed successively from the chamber. Each section is then stripped of its rubber coating, and the latter is pressed into a solid block weighing anywhere from 150 to 200 pounds. The rubber produced in this manner is exceptionally pure and of a distinctly superior grade.

The disk-spray process provides a new and much-improved method for mixing crude rubber with the various ingredients which must be added to it during the manufacture of the basic rubber compounds required for the making of different articles of trade. In the past, the crude rubber, after arriving at the factory in a hard, dry state, has been cut up and then worked into a soft dough by passing it repeatedly through powerful, hot rolls. The compounding ingredients were then poured over the soft dough and the mixture again put through the rolls several times to knead it into as uniform a mass as possible.

The new process renders it practicable to spray the compounding materials from the disk simultaneously with the latex, thus assuring perfect commingling of the various substances and producing a dough of uniform quality capable of meeting the most exacting specifications. Enough has undoubtedly been said to make it clear that this development represents a long stride forward in the rubber industry. The betterments that will probably be realized are too numerous to mention here.

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Latex from Sumatra being transferred from a steamer to tank cars for shipment to the factory.

An inspection trip was made recently by members of the staff of the United States Bureau of Standards for the purpose of studying the weathering qualities of various kinds of natural stone in actual use. One of the outstanding facts brought out was the tendency of builders to get materials from afar when as good, if not better, could be obtained close at hand.

How Compressed Air Speeds Production in a Furniture Factory

By H. J. LONG

"GOOD FURNITURE, from tree to crate" is the unique slogan of the Victoriaville Furniture, Ltd., a small but exceptionally well-equipped factory located at Victoriaville, Que. The company owns large tracts of timber and operates two sawmills, so that it is actually in full control of its product at every step from forest to shipping platform. By reason of these advantages, together with a plentiful supply of labor, careful management, and good markets within economical shipping distance of the plant, the concern has been successful from the start.

Compressed air plays an essential part in the operation of the factory and, according to Mr. J. E. Alain, the managing director, it would be hard, indeed, for them to get along without it. However, before entering into a detailed description of the various applications of compressed air, a few words regarding the company, its general manufacturing system, and its product may be of interest, particularly to those not familiar with a modern furniture factory.

One of the most important elements of factory management is the proper arrangement of departments and the subdivision of those departments into sections where the men are engaged on definite operations. By this method the men become very efficient in their particular work, owing to the fact that they are employed on it, and it alone, month after month. This is the system which has been adopted at the plant under discussion. Founded in 1894, the company was formerly known as the Victoriaville Furniture Company, Ltd. In 1920, it was reorganized, and in March of that year it was purchased as a going concern by the present directorate.

The main part of the business for many years was the manufacture of medium-grade case goods—that is, dressers, sideboards, and other box-like pieces—in surface oak, printed mahogany, or other finishes. A radical change in policy was decided on by the new owners and, as a result, they are now turning out solid-walnut, quarter-oak, birch, and mahogany furniture. The directors, in making the change, were of the opinion that abundant raw materials, a well-equipped factory, proximity to markets, cheaper freight rates as compared with those enjoyed by more distant plants, and a good supply of labor at wages which are not as high as in some other furniture-making centers were factors that would contribute to success. The tracts of timber owned by the company are 5,000 acres in extent and are situated, with one of the mills, at Paul de Chester, fifteen miles from Victoriaville. The second sawmill is at Notre Dame de Ham.

In entering upon the manufacture of a better grade of goods, numerous alterations were made in the production system and in the arrangement of the departments with a view to securing the highest efficiency. The work has been thoroughly systematized; and a great deal of attention has been given to the routing of the unfinished product from one part of the factory to another.

All the furniture is designed by the designing staff of the plant. In addition to detail drawings, rods or instruction boards for factory use are made. These rods are of clear basswood, and are coated with shellac and varnish. They show the full size, elevation, etc., of the pieces, cross-graining being indicated by red and blue markings. Every piece shown on the rod is numbered and indexed. For example, 1 means top; 2, front parts; 3, back parts; 4, gables; 5, front rails in frame; 6, back rails in frame, etc., etc. A board of this description accompanies the job through every department, and it is so explicit in its instructions that a mistake as to the details of the work is almost impossible. In this respect, its function is similar to that of the job ticket or route card used in metal-working plants; and it gives the workman all the information necessary, thus obviating waste of time in seeking instructions from the foreman.

Plant of the Victoriaville Furniture, Limited, Victoriaville, Que.

About 125 men are employed in the factory, which is a well-lighted building of three stories having a floor space of 95,200 feet. It is equipped with an automatic sprinkler system. During the summer months this system operates on the "wet-pipe" method, while in the winter compressed air instead of water is employed, as the latter is apt to freeze in the piping. In case of fire, the fuses in the piping are melted by the heat—thus allowing the air to escape. The water is then carried through the piping and released in the usual way. Air at a pressure of 35 pounds is used for this purpose; and, of course, the substitution of air for water prevents freezing and bursting of pipes. This "dry-pipe system" is widely utilized in Canada.

The lumber yard is of ample size and carries a minimum stock of 1,000,000 feet, while

the kilns have a total capacity of 100,000 feet of lumber. The kilns consist of four sections and operate on the moist-air system of the National Dry Kiln Company of Indianapolis, Ind. They can accommodate 56 trucks. After being dried, the lumber is conveyed on the trucks to the machine shops, on the ground floor of the factory. In this department every piece is routed through in order; and at each operation the pieces are counted and sorted—this rule being strictly enforced in order to prevent waste.

Two elevators are in service: one takes the pieces up as soon as they are ready for sanding and assembling, and the other, at the opposite end of the factory, carries down the finished goods.

Space will not permit us to describe in detail the various operations in the machine shops, where the work is prepared for the cabinet department. The equipment, however, includes breaking-out and cut-off saws; self-feeding rip saws; an automatic log lathe; a dovetailing machine; a lock and keyhole machine, etc. There is also a Linderman automatic jointer and gluer, which is regarded as one of the most efficient apparatus in the entire plant. In the shops and the other departments, trucks are used to convey the various pieces from machine to machine. These trucks have proved great labor savers, eliminating the loss of time involved in piling the different parts on the floor and then in removing them. It has been found to be more economical to spend money for trucks than to pay wages.

The repair shop and saw-filing room is at one end of the machine shop. The cabinet department, on the second floor, is well arranged for economical production: all the benches and machines are placed along the sides of the room under the windows, assuring maximum light. This department is divided into three sections where sanding, assembling, and chair work is done, and each is suitably equipped for the purpose.

In the sanding section, triple-drum and disk sanding machines are used to smooth up the various parts of a dresser, buffet, or table before they go to the assembling section. The sanding drums, which are covered with different grades of sandpaper, soon become filled with wood dust, thus losing their abrasive qualities. Prior to the application of compressed air, it was necessary to remove the paper frequently. This took considerable time, aside from the cost of the paper, which was high. An air jet now cleans both the machine and the sandpaper rolls in a few minutes—thereby not only speeding up operations but increasing the useful life of the paper.

From the sanding machines the parts next pass to the assembling section, where the idea of specialized work is also carried out to the fullest extent. For instance, all the gables are put together at the gable clamp, and the cases or frames of dressers, etc., at the revolving case clamp. The latter machine will take a 6-foot case. One man does nothing else but assemble drawers; another dressing tables or *toilettes,* as the French-Canadians term them; a third makes dining tables only, and so on. Others are engaged in fitting the cases with drawers, doors, etc.—in short, everything is so arranged that the men, by repetition, attain a high degree of efficiency. Instead of a central glue kettle, each operative has his own glue pot fixed above his bench—heat for this purpose being drawn from the boilers. This is a typical example of the many labor-saving devices adopted to speed up production and to save time.

The equipment in the cabinet department includes a multiple boring and mortising machine, a 3-spindle borer, a double borer, a bed-case clamp, and a *toilette*-case clamp. The latter was made in the factory and is regulated by hand wheels and screws, giving a uniform side pressure. It will take any size case.

When assembled, the various pieces of furniture or "goods," as they are termed in general, move on to the finishing department. This is divided into five sections to meet the needs of the following operations: staining and filling, sanding and shellacing, varnishing, rubbing and cleaning and enameling. The latter finish is given only to certain pieces.

Shellac is applied with a DeVilbiss air brush in conjunction with a specially ventilated hood and a pneumatically operated table, which permits the product to be turned or raised so that all parts of it can be reached without the necessity of touching it by hand. The shellacing of dresser drawers is a slow job when done by hand on account of the many corners. By means of compressed air, however, the work is performed so quickly that one man with an air spray can accomplish in a given period as much as eighteen hand painters. Ordinarily, in factories of this class, the use of compressed air increases the efficiency to a point where one man can do the same amount of work that formerly took from five to ten.

Compressed air also serves to apply varnish when the shellac has dried. The equipment utilized for this purpose is similar to that employed for spraying the shellac, and includes air-operated tables and ventilated, protecting hoods. The latter are provided with fans to carry away the fumes. The fans were at first operated by little electric motors; but as these heated badly they were subsequently replaced by small air motors or turbines.

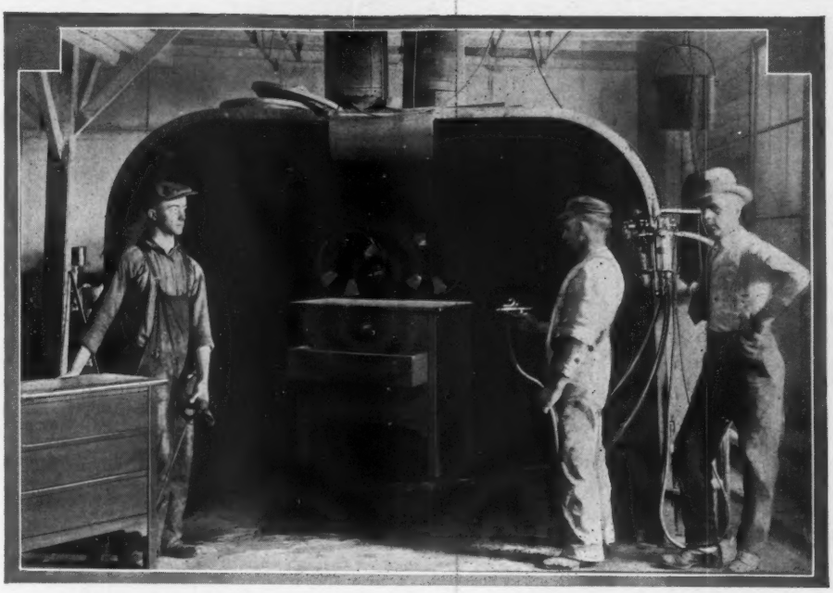
A complaint sometimes raised against pneumatic paint spraying is that the fumes are injurious to the operator. However, in the plant under consideration the men suffered more often from fumes when hand painting was in practice than since air sprays were adopted. This is probably due to the efficiency of the ventilating system and to the fact that so much less time is required to varnish each piece. Actual comparison shows that a painter with an air brush can apply as much varnish in one minute as he could put on by hand brush in twenty minutes—hence the operator is not now exposed to the fumes for as long a period on a given job. It is also interesting to note that the ever-ready air jet is used to clean the furniture prior to painting and shellacing; and it can

Oval—Electrically driven Ingersoll-Rand compressor which furnishes the operating air for various purposes in the factory.

Right—In the polishing department, where pneumatic rubbing machines speed up the work of rubbing and polishing the furniture after the woodworker has completed his task.

readily be appreciated that the ease with which corners can be painted by compressed air is of outstanding advantage.

Most of the pieces receive three coats of varnish before they are ready for the polishing room. Here a number of Mattison pneumatic rubbing machines are employed with excellent results. Rubbing down and polishing varnish is a slow and laborious job when done by hand, but with the air-driven rubbing machine practically all the operator has to do is to move the apparatus from place to place.



Compressed air being used to spray shellac on a dresser during one of the finishing operations.

In the varnishing section, movable drying racks have proved of great value in saving time and labor. First, the empty racks, which are fitted with ball-bearing casters, are taken to the paint sprayers. After painting, the various pieces are placed on the racks, where they are left to dry. When a second coat is required, the full racks are wheeled in place, the furniture parts are sprayed, and again left to dry. The racks are big enough to take bed or *toilette* frames and buffet backs. Platforms, likewise on ball-bearing casters, are used for drying and for conveying dining-table tops.

Compressed air has still another service to perform: it cleans the boilers. For this work it has been found much more satisfactory than steam or hand labor. It requires only about twenty minutes to clean a boiler by air as against two hours by hand.

To supply the needful air for the various pneumatic devices in use throughout the factory, the Victoriaville Furniture, Ltd., has recently replaced its old compressor with an up-to-date Class ER-1, single-stage, short-belt, motor-driven unit. When speaking of this addition to their plant, Mr. Alain forcibly brought out the importance of compressed air in the modern furniture factory.

As he expressed it: "We have just realized, now that we have an adequate supply of compressed air, how a shortage of air can hamper the efficient operation of a factory. Until the new machine was installed, we never appreciated under how big a handicap we were laboring; and it is a great satisfaction to know that we are turning out more work without additional men. At first we hoped to avoid the expense of a larger compressor; but, considering the increased production, we are certain to be reimbursed for the outlay within a short time. Furthermore, the workmen are always kept busy, while previously there were frequent delays on account of air shortage."

SWITZERLAND EXTENDS HER ELECTRIFIED LINES

SWITZERLAND'S progress in the electrification of her federal railways system is illustrated by the completion, on June 1, of the present year, of the line from Chiasso, at the Italian frontier, to Basel, at the German-French frontiers—a continuous stretch of electric traction reaching from one end of the country to the other and having a length of 197½ miles. This brings the total electrified trackage to 315 miles.

The electrification program of the Swiss Federal Railways is a result of the severe economic conditions which existed in Switzerland during the war, when her people were dependent on foreign countries for coal and were forced to purchase it at extremely high prices. The necessity of having to go abroad for fuel to maintain steam traction led to the adoption of a plan to electrify all the important lines of the Swiss Federal Railways.

The electric energy for the operation of the Chiasso-Basel line is furnished by two power houses, located at Ritom and Amsteg, aided by the Goeschenen plant at the northern entrance of the Gotthard tunnel. The two aforementioned hydro-electric stations can deliver throughout the year an average of 32,000 H.P.; and it is expected that 72,000 H.P. will be developed when the Ritom plant is fully equipped.

SANDBLAST CARVES WOOD

IN THE NEW $400,000 Hotel Emerson, at Hoquiam, Wash., sandblasting equipment was put to the novel service of decorating the natural woods which are a feature of its interior. Stencils, cut in artistic designs, were laid over the wood surfaces, and then the sandblast was played upon the stencils. The effect is that of hand carving; and flowers, birds, and various industrial products of the State of Washington were thus beautifully reproduced. Over 600 stencils were used. The sandblasted wood is left in its natural tone, while the figures are touched up here and there with color.

The main pillars, 26 inches through and 23 feet from floor to ceiling, have a different design on each side. In the grill, the sandblast carving ornaments the fire-place and the doors, and gives a finish to the silver-gray panels on the ceiling and elsewhere. The color scheme is silver, gold, and black, which is pleasing to the eye.

A jet of compressed air is here employed to clean the sandpaper on a triple-roll sanding machine.

How Gold Mining on the Rand Has Made History

Present Rate of Output of the Greatest Gold Field and the Biggest Mining Camp Amounts to 55 Per Cent. of the World's Current Production of This Precious Metal

By OWEN LETCHER*

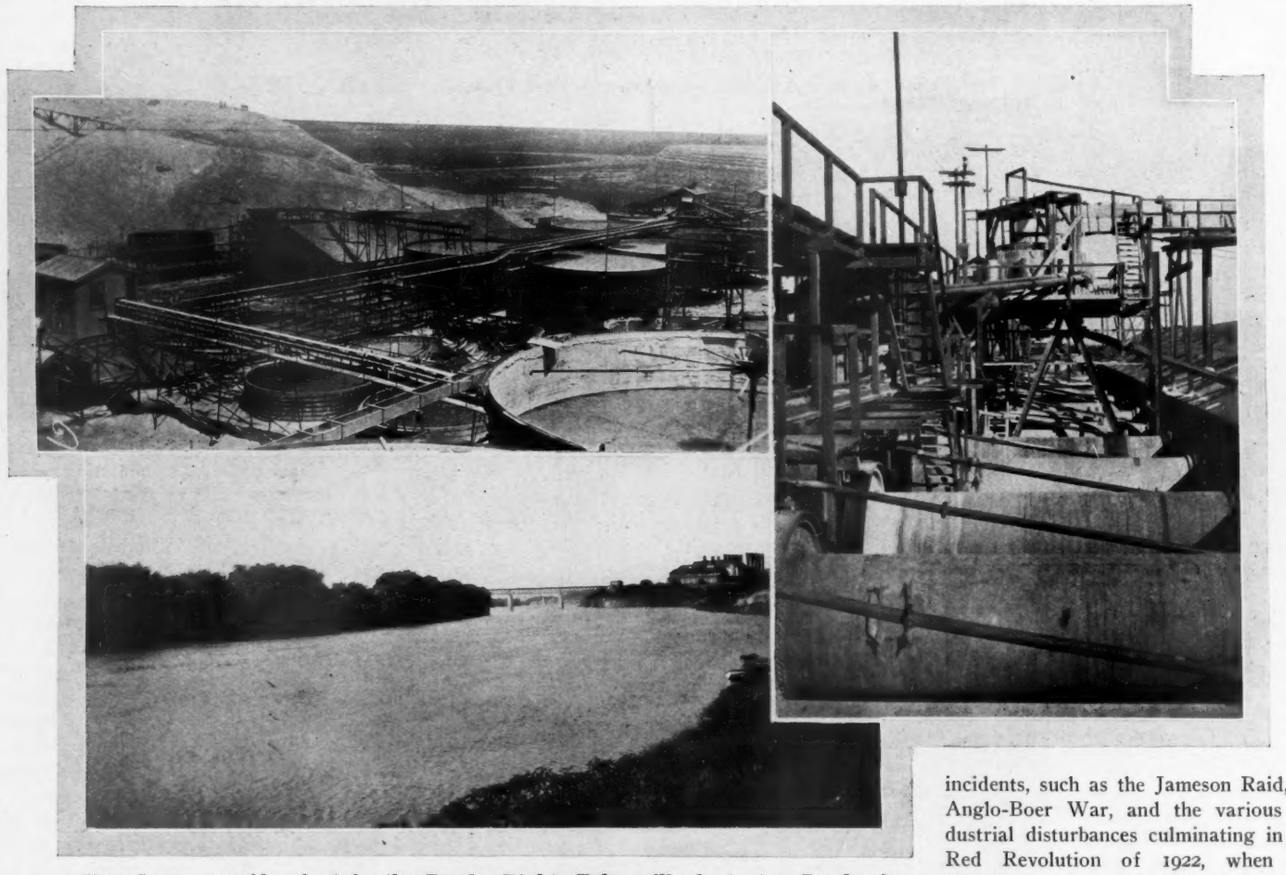
THIS YEAR the gold mines of the Witwaters Rand in the Transvaal will probably produce 9,000,000 fine ounces, thus establishing a fresh record in the achievements of this remarkable field which is at present contributing about 55 per cent. of the total gold output of the world. Up to the end of 1923, the Rand had yielded approximately 172,500,000 fine ounces having a gross value—including the premiums of the past four years—of £762,000,000 or, say, $3,350,000,000 at the present rate of exchange.

In order to accomplish this, underground excavations have been driven, sunk, and risen, having a total development footage amounting to over 3,000 miles in length, or the equivalent of a tunnel long enough to traverse the Atlantic from New York to Bristol, England; and nearly 500,000,000 tons of ore have been put through the crushing and treatment plants. The major portion of this colossal mining undertaking, so far as footage developed and tonnage broken are concerned, has been achieved through the medium of compressed air; and it is an interesting fact that a large percentage of the gold distributed throughout the globe has, in no small degree, been won from the depths of the South African high veld by the employment of rock drills built in America.

There are at the present time many such machines in daily operation along the 70 almost continuous subterranean miles which constitute the Rand; and recent research work has proved that small, light drills of the "Jackhamer" pattern are capable of substantially augmenting the breaking capacity of the native labor force; of reducing mining costs; and of bringing many millions of tons of low-grade rock within the zone of payability and thereby greatly prolonging the workable life of the auriferous deposits.

Thirty-eight years ago the gold-bearing conglomerate beds of the southern Transvaal were discovered; and it may truly be said that ever since those "early days"—when financiers and mining engineers, diggers, and adventurers from all over South Africa, and indeed from every corner of the world, began to flock to the "Poker Flats" settlements along the wind swept "Ridge of the White Waters," as the Dutch word Witwaters Rand is to be interpreted—the central feature in all the engaging dramas which have been staged in kaleidoscopic South Africa during the last third of a century has been the gold of the Rand. Around this dominating factor have centered all the stirring incidents, such as the Jameson Raid, the Anglo-Boer War, and the various industrial disturbances culminating in the Red Revolution of 1922, when the "Reef"—as the gold field is known—with its central and strategical town of Johannesburg very nearly fell into the hands of a few lawless individuals and political adventurers. And around this central picture of the gold fields flit the personalities of Cecil John Rhodes and Paul Kruger, Louis Botha, and Jan Christian Smuts. These men have shaped the destinies of South Africa; and the life story of each of them has found its motive force in the circumstances which have arisen from the development of the Witwaters Rand gold fields and which turned a poor, pastoralist and little-known republic into an exceedingly rich country.

If we look into the fascinating picture more



Top—Large cyanide plant in the Rand. Right—Tube mill plant at a Rand mine. Bottom—One of the Rand's power plants at Vereeniging.

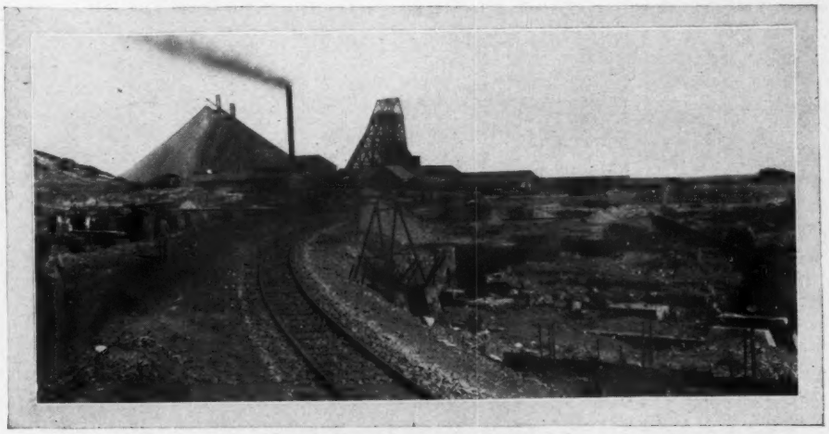
*Editor, South African Mining Journal.

closely we shall see, too, how men like John Hays Hammond—the American mining engineer—and Weinber, Beit, Lionel Phillips, George Farrar, and Rhodes' brother, Colonel Frank, were tried for their lives for participating in the Jameson Raid and just escaped the death penalty. These men, by virtue of their associations with the mineral deposits, helped to shape history in South Africa. Likewise, we shall see how the fortunes amassed at Kimberley in the "seventies" provided the sinews of war for the conquest of the "Barbaric North;" brought about the opening up of Rhodesia; and gave the impetus to railroad construction over the Zambesi and up to the great copper fields of Katanga and beyond until, today, the forging of the Cape to Cairo rail and river routes has come within measurable distance of being *un fait accompli.* So much has the exploitation of the mineral resources, and principally the development of the Rand, shaped the history of Africa south of the equator.

The wider aspect of this entrancing story of accomplishment finds expression in the query: "To what extent has this helped in the molding of the present-day world?" The answer to such a question is too big a thing to essay within the compass of this article. But there is food for thought in the reflection that the Rand is today yielding gold at approximately twice the rate at which the whole world was producing it immediately prior to the discovery of the "banket" or conglomerate beds in the southern Transvaal. If gold be the basis of barter, and there is a more or less fixed ratio in commodity prices as between these values and the volume of the gold output; if the possession of gold be necessary for the prosecution of international warfare and the conduct of international peace—and on these points the savants are agreed that gold is the essence of the matter, who would dare limit the influence of gold production on recent history? The Tibetans believe that gold breeds, and that the atoms of this precious metal should, therefore, not be disturbed during the lengthy process of mating. Be all this as it may, the production of gold by the mines of the Rand constitutes the greatest industry of the country, without which the Boer farmer would not have markets for his produce and the state treasury would be empty.

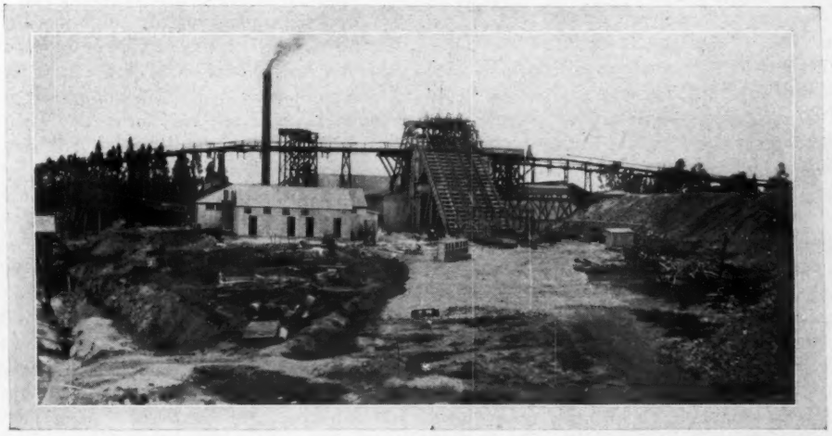
It is no doubt true that the ordered functions of the gold-mining industry, operating through numerous channels of ramification, have provoked local wars and revolutions and have taken their tolls in the lives of men and in the sufferings of women and children. Against all mining areas the same indictment might be framed. All that can here be said is that for years past the mining companies have prosecuted a vigorous campaign against the dust evil and accidents. Rand sandstone, when drilled into, powders up into acicular particles, which perforate and silicify the lungs.

In the earlier days of the fields, the mortality from this cause among miners was distressingly high. Of recent years the mine managements, in conjunction with the government, have undertaken a vigorous campaign against phthisis, with the result that the prevalence of this disease has been greatly reduced. Rigorous and systematic examination of the respiratory



Scene at the Randfontein mines.

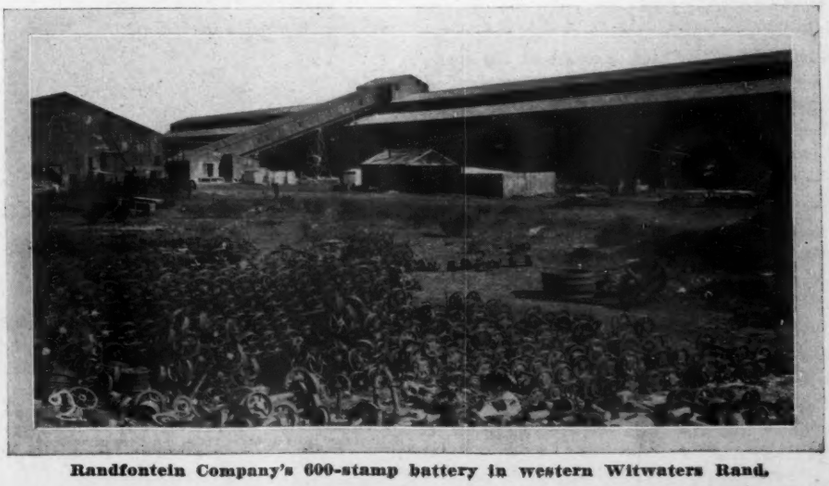
organs of miners; the use of hollow, water-fed bits on machine drills; and the employment of other dust-allaying devices, together with improved methods of ventilation and the establishment of what is probably the finest medical bureau concerned with occupational diseases in the world, have resulted in enormously reducing the incidence of the malady. But, even



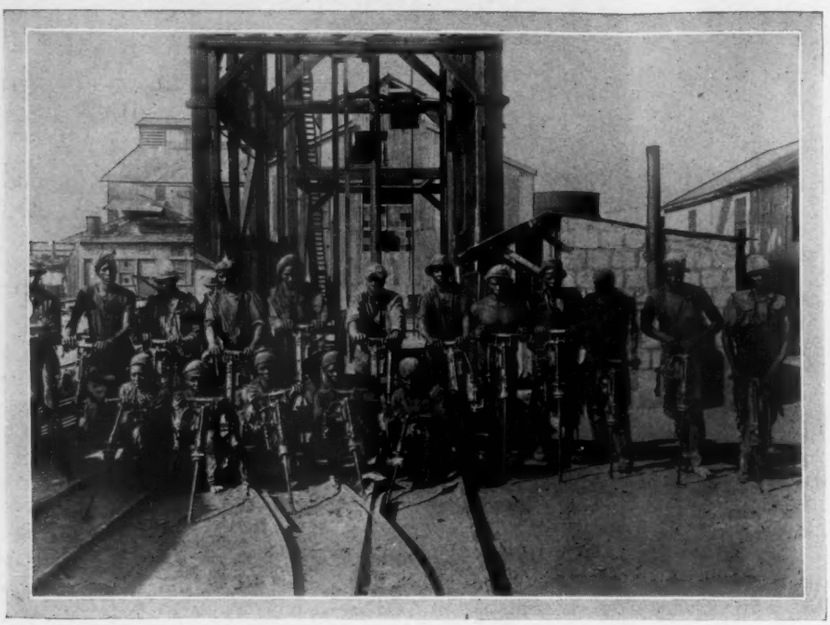
Operations at a typical Rand outcrop.

so, the mine operators on the Rand have up to date paid out over $30,000,000 in compensation to phthisis sufferers and their dependents. Accidents are principally caused by falls of ground; and in consequence of an intensive safety-first campaign the death rate has been reduced from nearly 4 per 1,000 to just under 2 per 1,000 in the past ten years. So much for the human side of the question, although much more might be written on the subject of the excellent conditions under which employees live, and whole columns might be devoted to details of housing schemes, paid holiday privileges, recreation, sick benefits, and general welfare projects. In these respects the 18,000 European and 180,000 native employees of the Witwaters Rand are at least as well off as any similar types of employees anywhere else in the world.

Let us turn now for a while from the more personal side of the picture to that aspect of the Rand which deals with man's triumph, through the medium of engineering skill, over the fort-



Randfontein Company's 600-stamp battery in western Witwaters Rand.



Group of Kaffir mine boys, in the Transvaal, equipped with air-driven "Jackhamers" which they have learned to operate with excellent results.

resses which guard the deep-laid treasures of Mother Earth. Nearly all the ore lying within 1,000 feet of outcrop, which fed the small equipments of the earlier days, has long since been worked out. The average stoping depth of the workings, which are at present supplying ore to the Rand's crushing equipments, is in the neighborhood of 3,500 feet; and ore is today being won on the central Rand from a depth of over a mile from the surface. The deepest mine on the Rand, and at the same time the deepest gold mine operating on a large scale anywhere in the world, is the Village Deep, which lies immediately to the south of Johannesburg. In this property the bottom level has been driven at a vertical depth of 6,206 feet from the surface, and even deeper work is in progress. To give this sinking performance an equivalent in a popular parallel it may be said that nearly eight Woolworth buildings, standing on top of one another, would just about reach from the lowest working in this mine to the shaft collar. The Woolworth Building, in New York City, is 792 feet high and is the tallest office structure in the world. This shaft, as well as that of the City Deep mine adjacent to it, will be down to a vertical depth of 7,000 feet from the surface within twelve months.

Stage electric hoisting has solved the haulage problems at the deep levels. Progressive increase in earth temperature is remarkably moderate. The only problem that presents itself is that of gold content in relation to working expenditure. It says much for the business organization of the Witwaters Rand and for the high degree of technical development attained there when it is stated that in the Village Deep a single thin reef, only about 18 inches wide and containing no more than 7 pennyweights of gold per ton, is yielding distributable profits on an issued capital of $4,500,000.

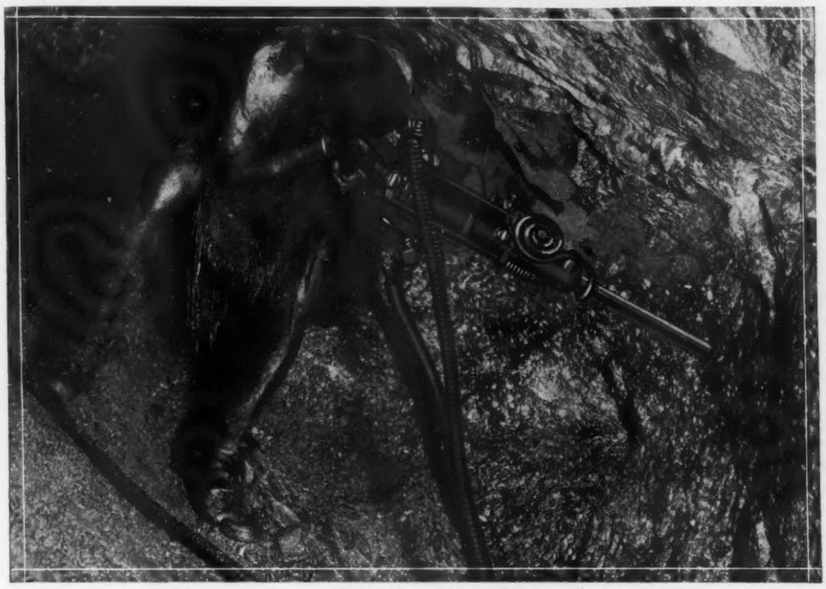
The crushing plants of the Rand are no less remarkable than the deep-level undertakings of the fields. Few people perhaps adequately realize the omniverous appetite of a modern reduction mill. There is one battery on the western Witwaters Rand—that of the Randfontein Company—which is the largest gravity-stamp equipment under one roof on earth. This mill has an overall length of 630 feet, it contains 600 heavy Californian stamps, and eats up ore at the rate of 210,000 tons per month, or more than the total computed weight of the Hudson Terminal Buildings in New York City, which together form the largest office building in the world.

The Randfontein and other stamp batteries on the Rand represent, however, what is probably a back number in metallurgical-engineering practice along the Reef. In the latest types of reduction and treatment equipments the stamp battery has been dispensed with. Preliminary breaking is performed by means of jaw or disk crushers; fine grinding of the ore to the degree of fineness required is consumated by tube mills; and the product passes on to the cyanide works. The corduroy concentrating table has largely replaced the amalgam plate; and the aims and objects of the designers of the "new metallurgy"—which are decreased capital and operating expenditure and augmented extraction—are being secured in actual practice.

The gravity stamp is a relatively cumbersome and costly appliance to install, but it has served its day; and the 500,000,000 tons of tailings, which litter the Reef from one end of the field to the other, testify to the service which the Californian mill has performed. The late President Paul Kruger at one time threatened to compel the mining companies to deposit these white mountains of sand back into the mines from whence they came. This threat was never translated into action; but during the last dozen years the mining companies, of their own volition, have lowered large tonnages into the workings to support hanging walls or sandstone roofs, although the great bulk of it stands there in a series of snow-white hills. These gigantic mounds probably contain gold equivalent to a year's production of the mines at the present rate of output; but the residues are not economically recoverable. And so the hills stand there, a silent tribute to the industry of those who have delved so deeply and so extensively into the crust of South Africa in the quest for that elusive metal for which men have been prepared to sell their lives since time immemorial.

A hundred years hence, perhaps even sooner, there may be little left along the Rand to bear witness to the fact that this region was once the greatest gold field in the world—a region inhabited by over 500,000 people who took their work seriously and their pleasures whole heartedly and who experienced some difficulty in living on 24 hours a day and on the interest of what they owed. For Johannesburg is in

How native hand-hammer boys work in such of the Rand gold mines where air-driven "Jackhamers" have not yet been adopted. This primitive method is fast being abandoned for the more effective and economical modern way of drilling.



Native mine worker operating a "Jackhamer" while stoping in a mine on the Rand.

reality nothing more than a mining camp. It is the center of this great auriferous tract; has a population of 150,000 Europeans and 136,000 non-Europeans; and is thus easily the premier mining camp of the world. It may pride itself on its civic dignity, its fine buildings, and its municipal services; and it may truly claim that it sets the pace to the whole of South Africa. But the truth of the matter is that it is nourished on gold and on nothing else. The gold dust has got into people's eyes. And yet we who live there—enjoying a gorgeous climate, a high standard of living, and a top-story rate of work and play, we who produce so much of this gold never see it nowadays except in the form of jewelry or artificial molars. The United States is the only country in the world today on a convertible paper into gold currency basis. A Rand miner who has dug the gold out of the main Reef cannot get his pay check translated into the precious metal: he has to accept inconvertible paper money as a token of the value of his labors. The great bulk of the gold which he and his mates produce is generally distributed throughout the world.

How long will the Rand continue to pour forth its stream of golden wealth? Has it yet reached the apex of its productivity? How much deeper into the bowels of the high veld will man penetrate in his search for the yellow metal? It is difficult, impossible in fact, to give any definite answers to these questions. But one may truly say that the longevity and prosperity of the field depends upon the working-costs factor.

No one is going to venture millions of money into new development schemes unless there is a reasonable prospect of an adequate recompense. There are on the outlying sections of this gold field vast areas which are known to contain gold at great depths; and there are other equally large tonnages of established or presumptive low value. The lower the costs can be reduced the larger will be the amount of ore that can be treated at a profit. Today, the average rate of working expenditure on the Witwaters Rand is slightly under a pound, or a little over $4 per ton. Since the collapse of the great strike in March, 1922, working expenditure has been reduced by $1.25 per ton; and this economy has made all the difference in the world to the profitability and, therefore, to the productivity of the mines. If costs can be maintained at their present level—better still, if they can be reduced below this level, then the Rand will in all probability continue to be the greatest known gold field in the world for a good many years to come. And in keeping this position, we are looking to compressed air and small drills to help us greatly.

The same type of machine that you may see hammering away on street work in New York City or elsewhere is making history deep down in the mines of the Witwaters Rand. It is helping to solve the working-cost problem upon which the future not only of the Reef but of South Africa, as a whole, so largely depends.

CASTLETON CUT-OFF NEARING COMPLETION

MORE THAN a year ago mention was made in our pages of the work being done by the New York Central Lines in constructing a bridge across the Hudson River south of Albany, N. Y., and in creating a great freight yard at Selkirk. This $25,000,000 improvement will permit the railroad to divert daily a matter of something like 8,800 freight cars from the present congested bottle-neck route through Albany. Furthermore, the new route will enable the road to shorten the time in transit of freight, bound to and from the west, anywhere from three to seven days.

The new steel bridge crosses the river a short distance south of Castleton. The structure, with its viaduct approaches, is a mile long, and it is high enough to insure a clearance of 135 feet between its underside and the waterway. Its position is such that trains running over the connecting railway will be able to avoid a very steep climb which they now have to mount in going west from Albany. The bridge is virtually finished and will shortly be ready for service.

No less contributive to the gain to be realized is the great freight yard at Selkirk, which occupies a flat area six miles long. The yard has been graded to accommodate about 11,000 cars; and space is available for an expansion which will permit it to take care of 20,000 cars. This terminal or exchange point will be illuminated by an overhead system of flood lighting—the electric lamps for this purpose being carried by tall towers; and the arrangement will render it practicable to carry on the work of making up trains and distributing cars with equal ease by day and by night.

FROZEN ALIVE BUT NOT TO DEATH

PROFESSOR PICTET of Geneva, Switzerland, world-famed expert in refrigeration, recently put two dozen fresh-water fish into a deep tray containing water nearly at the freezing point. This temperature was maintained for 24 hours, and then the water was slowly frozen into a solid cake of ice encasing the fish. The block was kept in a freezing apparatus for two or three months at 4° F. below zero and then very slowly and carefully allowed to thaw. The fish revived and swam about in the restored water. Repeated experiments have shown that the aforementioned temperature is the lowest at which the life of fresh-water fish can be sustained, although some other creatures can survive much lower temperatures.

PAPER-BOX INDUSTRY AN IMPORTANT ONE

AS FAR back as 1800, the manufacture of paper boxes in the United States was an established industry, and in 1850 there were 82 factories in the business. Ten years later, inventive genius began to devise machinery for the fabrication of paper boxes which had, up to that time, been made entirely by hand. From then on the industry grew apace.

In 1919, when the last survey was conducted, the capital invested in the business amounted to $57,000,000; the annual output was valued at $125,000,000; and 57,000 people were employed. These figures, mark you, cover the so-called "set-up" box trade only; and they show a gain in value of output in ten years of substantially $70,000,000.

LONDON'S BRIDGE TROUBLES

LONDON, not being "builded upon a rock," as is New York City, for example, has troubles of its own, and especially as regards its bridges. Waterloo Bridge may be said to be actually settling into the ooze. It has been bolstered up, so to speak, to serve restricted traffic until a temporary bridge can be made ready. Westminster Bridge is causing much anxiety, and is being studied while carrying its accustomed traffic and while closed and unloaded. The proposition to build another bridge near St. Pauls is being held in abeyance because it is feared that its construction might imperil the cathedral, which is already in a weakened state. It has been suggested that London again try a suspension bridge, as it did many years ago.

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EDITORIALS

A THIRTEEN-MONTH YEAR

FOR A GOOD long time thirteen has been considered the unlucky number, and widespread has been the effort to dodge it whenever possible. Now comes a group of scientists that for rather convincing reasons strongly advocates dividing the year into thirteen months composed of 28 days each. This would leave an extra day which would be set aside for New Year's Day.

The plan, if carried out, would start the first of every month on a Sunday. To the restfully inclined this arrangement is bound to make a strong appeal; and, similarly, to the person who has to pay up on the first of each month hereby would be offered him 24 hours of added leeway. At first blush, the salaried worker, if paid by the month, might be disposed to rejoice; but it is needless to remark that the business manager will see to it that the annual compensation is apportioned accordingly, and right there the unlucky character of thirteen would again be in evidence. It is not difficult to picture the indignation of that portion of the editorial fraternity that now has to turn out a periodical every month. These toilers have their hands full as it is.

Perhaps, the feminine portion of the population and the purveyors to the fair sex would welcome a 13-month year because we are assured that such an arrangement would make Easter a fixed instead of a shifting festival and, therefore, would permit Easter Sunday to be set on a date likeliest to bring balmy weather and a sunlit sky. The substitution of a 13-month year will surely be opposed by the advocates of variety; and for most of us there has been a measurable amount of mental training in memorizing that combination of doggerel and free verse which deals with the number of days in each and every month of the existing calendar year.

TO PUT THE SUN TO WORK

NOT LONG ago a new's account from the Pacific coast proclaimed that MARCEL MOREAU of San Francisco had perfected an apparatus by which he could effectually concentrate and utilize the sun's heat for mechanical purposes. Incidentally, we were told that he relied in part upon a bowl-like arrangement of mirrors which would reflect and focus the sun's rays upon a given point where heat enough could be centered to melt and to transform a diamond into gas in the course of an extremely short period of time.

It is interesting to recall that the present inventor is one of a fairly long list of kindred spirits that have tackled the same problem since 1615. It may not be generally known, but the fertile-minded ERICSSON, of *Monitor* fame, constructed no fewer than seven solar engines in the course of something like thirteen years. He finally abandoned his labors in that direction when he discovered that he could obtain but a single horse-power from 100 square feet of reflecting surface. That was during the "sixties."

Between 1910 and 1913, FRANK SCHUMAN, of Philadelphia, was absorbed in this department of mechanical research; and, by means of a plant erected at Meadi, on the edge of the Desert of Sahara, he achieved notable results although not of a character to encourage the belief that solar engines would soon be of much practical service.

The SCHUMAN-BOYS absorber, as the apparatus was called, was capable of producing 12 pounds of steam per 100 square feet of sun-reflecting surface, which was equivalent to 183 square feet per brake horse-power, at a maximum thermal efficiency of 40.1 per cent. When we recall that a well-designed steam boiler operates at an efficiency of 70 per cent. or more and generates high-pressure steam, the solar boiler as a source of energy does not appear to be a formidable rival of the familiar fuel-burning equipment. However, MARCEL MOREAU may have discovered means by which to overcome the shortcomings that made earlier efforts in this field of little practical value.

Some day some one will master this fascinating problem and make us less dependent upon wood, coal, and oil for mechanical power. The fact that lures is that the sun in its noonday glory transmits to the earth a matter of 5,000 horse-power per acre! It ought to be possible to utilize this radiant energy—at least it seems so to the undismayed inventor.

STILL GROWING APACE

THERE are certain of our citizenry that take particular delight in figures of magnitude. To these gentry it will be gratifying news to learn that our population has passed by a goodly margin the 100,000,000 mark. According to the United States Census Bureau, we now have within our borders a total of 112,078,611 inhabitants—literally, that was the state of affairs on July 1, and it has no doubt been amplified somewhat in the meantime.

During the past year, 11 of our cities climbed into the 100,000-population class, making the total of these now 79. As heretofore, New York stands first in population—her dwellers numbering 6,015,504—with Chicago a somewhat distant second, having 2,939,605 persons within her gates, while Philadelphia ranks third with a total of 1,951,076.

Not only are we expanding in population but we are growing richer in the material evidences of prosperity. The United States Department of Commerce has told us recently that our visible wealth in the form of real and other property has increased to $320,803,862,000! At least, that is what we were worth in 1922. To be exact, our so-called visible wealth increased fully 72 per cent. in the decade between 1912 and 1922. This showing of prosperity is well enough in its way, but the understanding citizen realizes that it lays an added burden upon him to use his share of the abundance well and wisely.

SAVING EYE SIGHT

STARTLING as the statement may seem to most of us, it is authoritatively declared that the sense of sight is the primary inspiration for substantially 70 per cent. of our muscular activities. Such being the case, it should be self-evident that our bodily welfare or safety is largely dependent upon the effectiveness of vision; and, similarly, our value in business or in industry may be fairly correctly measured by the state of our eyes and their capacity to meet the demands made upon them.

Defective vision is not necessarily the consequence of gathering years, as it once—and that not so long ago—was commonly believed to be. We know now that visual shortcomings may be present in extreme youth; but the probable results of neglect of these imperfections are not generally heeded.

According to experts familiar with the subject, it seems that investigations have revealed that quite 60 per cent. of our school children have defective vision. Some of these defects are undoubtedly inherited; but a very considerable percentage of the observed faulty vision is attributable to misuse or unconscious abuse of the eyes before the children are old enough to go to school. Inasmuch as these youngsters must eventually assume their places in the working world, it is vitally important that every possible care should be given their eyes during the years they are busy with their books. Because this is not uniformly done, the condition is aggravated; and young men and young women entering gainful occupations start out with a visual handicap. It is no won-

der then that fully 60 per cent. of our workers have impaired eye sight of varying degrees of seriousness.

When it is brought home to us that we are living in an age marked by an astounding use of machinery; that the proper working of this machinery is fundamentally dependent upon accuracy in manufacture; and that this precision, in the last analysis, is determined by the keenness and the sureness of the skilled artisan's eye, it begins to dawn upon us how vital it is to have good eye sight.

Imperfect lighting is responsible for much eye strain and lasting injury to vision. This fault is present in the home, in the school, in the place of business, and in the factory. Conversely, proper illumination may effect very pronounced betterments. For instance, improved lighting, besides helping the eyes, has been found to increase the output 2 per cent. in certain steel plants and to augment production as much as 10 per cent. in textile mills and factories.

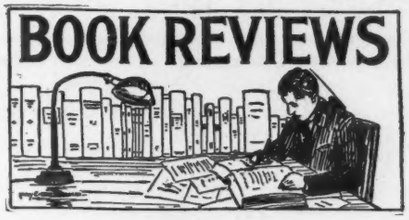
WHAT SIMPLIFIED PRACTICE IS DOING

AMERICAN INDUSTRIES are rapidly awakening to the economies that can be accomplished by reducing excess variety in styles, sizes, or types of manufactured commodities, thanks to the initiative taken in this direction by the Division of Simplified Practice of the United States Department of Commerce.

According to a Government report, the lumber industry of the country, one of the biggest and most spendthrift of our productive activities, has through standardization and simplification brought about changes which will go a long way towards checking an annual waste totaling $250,000,000. Other simplifications, which became effective on the first of last July, were: metal lath, reduced from 125 to 24 varieties; hotel chinaware, in which 700 or more items were cut down to 160; forged tools, in which an elimination of 46 per cent. was made in types, sizes, and weights; paper, in which 8 sizes and their "doubles" were adopted as standard for all general uses, thus offering opportunities for enormous economies; and roofing slate, in which the reductions were from 21 thicknesses to 10, 60 sizes to 30, and 17 descriptive terms brought down to 8.

Kindred improvements have been achieved in the manufacture of woven-wire fencing, in the sizes and kinds of milk bottles, in the types, sizes, and weights of hollow building tile, in the making and marketing of hardware, plumbing fittings, steel barrels and drums, etc. In short, this work of standardizing is continually widening and reaching into more and more departments of our industrial life. As may be readily grasped, the doing away with needless varieties will inevitably lead to tremendous economies and will make it possible for the manufacturer's dollars to go farther in meeting market demands. Incidentally, it will enable the ultimate purchaser to get more for his money.

Approximately 12,000,000 pounds of rope and twine are manufactured annually in Cuba.



THE ENGINEER, by John Hays Hammond. A work of 218 pages, published by Charles Scribner's Sons, New York City. Price, $1.00.

THIS particular volume is really a new and enlarged edition of a work that has enjoyed world-wide recognition for some years because of the substantial character of its treatment and the lucid manner in which the author has handled a topic thoroughly familiar to him. Primarily, Mr. Hammond set out to sketch a possibly wide field of usefulness for youths confronted with the problem of choosing a profession. His desire was to show these young men how they would have to qualify and how they might be called upon to apply their talents and their training in meeting the manifold demands made upon an engineer.

In his preface, the author says: "The engineering profession broadens perceptibly in scope with each succeeding year. The fundamentals remain the same. There is no reason, therefore, for changing anything in this book. Yet even in the short time since its first publication I have seen the need of adding to it. The field has enlarged, the lure of the profession has increased, the opportunities have multiplied."

Mr. Hammond has sketched in a picturesque fashion the background and the present climax of the professional engineer; he has drawn clearly the advantages and the shortcomings of the calling; and he has painted with a sure hand a picture of the essential qualities of an engineer, his acquired ability, and what must be the scope of his general education. Very wisely, the author has devoted an entire chapter to the English language—emphasizing the importance of a thorough grounding in the tongue and its proper use. We heartily commend this book to the would-be engineer.

THE STORY KEY TO GEOGRAPHIC NAMES, by O. D. von Engeln, Ph.D., Professor of Physical Geography in Cornell University, and Jane McKelway Urquhart, A.B. A work of 279 pages, published by D. Appleton. Price, $2.00.

NAMES of places, mountains, rivers, and other points of geographical interest or importance are generally without significance save as a means of identification. However, these appellations have, as a rule, some historical association or tell stories of the peoples that made these names permanent. In short, a knowledge of thousands of geographical names brings to light traditions, momentous happenings in the past, and the colorful imagery of the remoter inhabitants of different parts of the globe.

In the present work, the authors take the reader on what might be termed a name trip around the world, explaining en route why the various geographical names were adopted and what they mean if they are of a descriptive character. As might be expected, the names of places in the United States are especially interesting because they reveal how many different nationalities and races have had to do with the nomenclature of the country and its physical features. This book can be read to advantage by young and old.

THE COAL INDUSTRY, by A .T. Shurick. An illustrated volume of 383 pages, published by Little, Brown, and Company, Boston. Price, $3.50.

SOONER or later, the question of coal touches each and all of us. In latter years, the public has been much disturbed at frequent intervals either by a seeming scarcity of fuel or by the mounting prices of this essential commodity. Recently, in its report, the United States Coal Commission has said: "The first step toward protection of the public interest is a better public understanding of the coal business. Guided by facts rather than rumors, by information rather than prejudice, the people will be able to exercise wisely the powers of government."

The purpose of the author is to supply a standard work which will cover the whole field of the coal industry from its very beginning as a fuel down to the situation as developed in the last few years. The book is comprehensive and deals with the subject from mine to consumer, and is a valuable contribution to the bibliography of this important department of human endeavor.

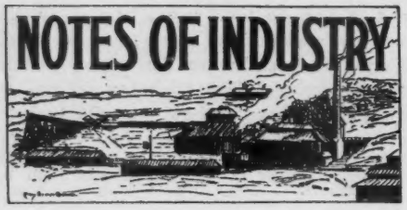
Rules for the Safe Handling and Storage of Cylinders Containing Compressed Gases have recently been published in folder form by the Janney, Steinmetz Company of Philadelphia, Pa. The widespread use of cylinders of this character makes their proper handling a topic of interest to many persons. A copy of the folder will be sent free upon request.

Thew Power Shovels is the title of a bulletin issued recently by The Thew Shovel Company, Lorain, Ohio, describing a new type of gasoline-driven shovel. Copies of this brochure will be sent to anyone interested in the subject.

WITH the growing need for the inspection of structural materials, there has been an increased demand for the formulation of proper methods for the inspection of Portland cement. Much has been written on this subject; but it appears that there is a real need for a paper dealing more fully with the problem. Based upon the experience of the United States Bureau of Standards in caring for Government purchases of cement, John R. Dwyer and Roy N. Young, of the cement section, have prepared a paper entitled, *Inspection of Portland Cement.*

This paper was published in one of the trade journals; but in order to give it wider circulation the Bureau, which is located at Washington, D. C., has had mimeograph copies of it made which may be obtained upon request. The information should be of assistance to those desiring to make thorough inspections of cement.

Europe absorbs more than 85 per cent. of the United States' exports of leaf tobacco.



The present annual blast-furnace capacities of the five principal pig-iron producing countries, based on actual accomplishments, are: United States, 45,000,000 tons; Germany, 10,900,000 tons; Great Britain, 10,500,000 tons; France, including Lorraine, 9,000,000 tons; and Belgium and Luxemburg, 5,000,000 tons.

In its effort to improve the Dominion's fuel supply, the Lignite Utilization Board of Canada, at Bienfait, Saskatchewan, is reported to have produced a modified Hood-Odell oven that has not only proved entirely successful but which is said to be easy to provide and inexpensive to build. It promises to put the carbonizing of lignite and its subsequent manufacture into briquets on a commercially practicable basis.

Railways are China's most pressing need. They would do much to unify the country and to open up nearly 2,000,000 square miles of territory now unsettled and undeveloped.

Government railway trackage in Japan will pass the 10,000-mile mark when a new trunk line, along the western coast of the main Island of Honshu, is completed late this year. The event is to be the occasion of a public celebration in the City of Osaka.

The State Undersecretary for Mines in Australia has issued a report showing that the actual coal reserves of New South Wales amount to approximately 20,000,000,000 long tons. These resources, after deducting a loss of one-fifth in mining operations, are valued at substantially 16,000,000,000 pounds sterling.

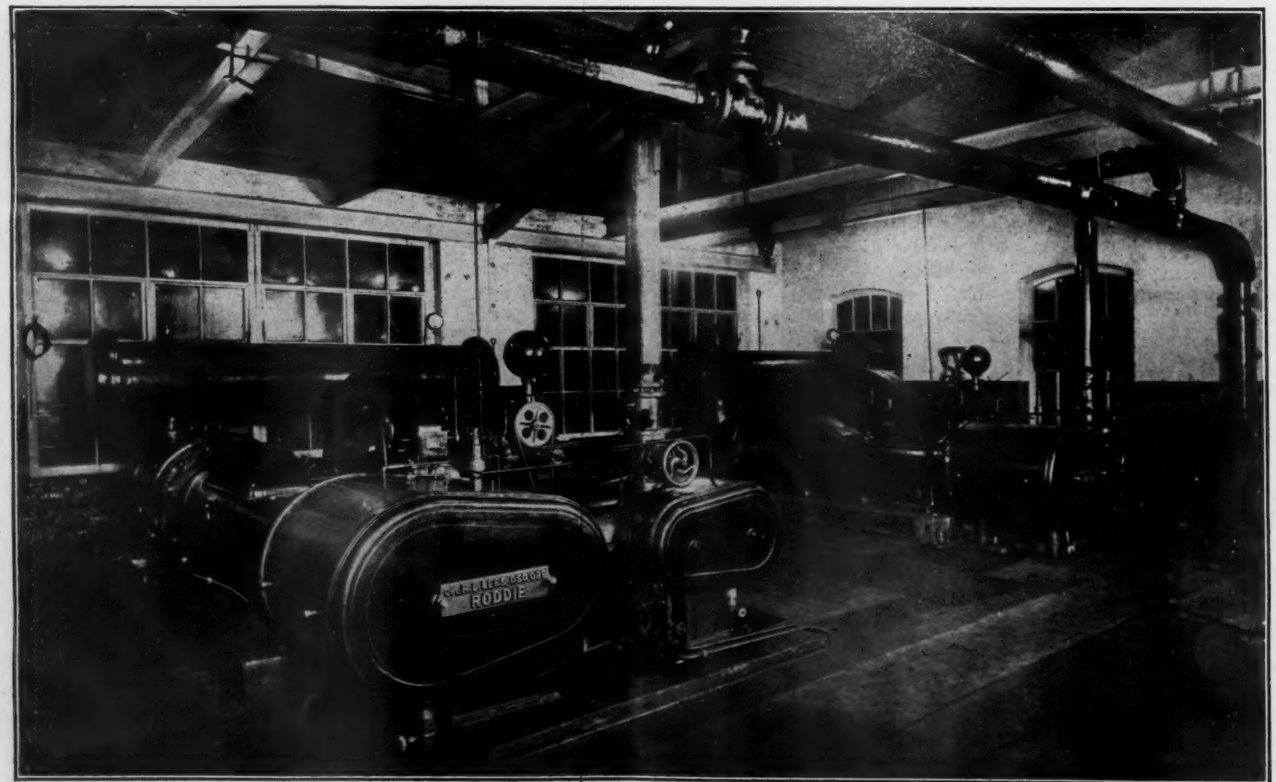
The consumption of paints in Chile is large because atmospheric conditions have a very destructive effect on them. We are told that municipal laws in nearly every Chilean city compel house owners to paint their buildings once a year. It should not be difficult to find a ready market for compressed air paint-spraying outfits in a country where there is apparently so much work for them to do.

Along the coast of Lower California, which is Mexican territory, an extensive business is developing in the production of excellent gelatine from the seaweed so plentiful there. There are as many as fifteen known varieties of the weed, which grow always on clean rock and at varying depths of from one to ten fathoms or more. Completely equipped divers follow the business of bringing it to the surface.

A solenoid chronograph, which has been perfected after four years of work on the part of the technical division of the United States Ordnance Department, now makes accurate determinations of the muzzle velocities of projectiles in actual flight. The projectile is magnetized before firing; and then is discharged through two coils of wire suspended at measured distances in front of the gun. The current produced by the passage of the projectile operates the recording mechanism.

The water supply of the City of Highland Park, Tex., comes from three Artesian wells, two of them flowing and one on pump, with a collective daily capacity of 1,200,000 gallons. The water as it issues from the wells has a temperature of 108° F., and is above 100° when drawn by the consumer. A 400,000-gallon reservoir is being provided with a spraying system for cooling the water.

There are now in the United States, on the authority of the Geological Survey, about 3,200 water-power plants of not less than 100 H.P. each that represent a total of more than 9,000,000 H.P., or an average of nearly 300 H.P. For obvious reasons this development is most complete in the first four of our New England States. If all sites could be similarly utilized the installed capacity, roughly estimated, would reach 72,000,000 H.P.—a figure which may or may not be approached on account of the cost of certain of the developments and the lack of demand within practical distances.



It has long been a custom in Lancashire, England, to give names to all machines in a power house. Here we have two 16-inch-stroke compressors which bear on brass plates the names of two sons of the owner of the Chambers Colliery Company. Because the camera had to do its work under difficulties, we might point out that the inscription on the machine at the left reads: Col. R. L. Lees, D.S.O., O.B.E., RODDIE, while the machine at the right carries on its dedicatory plate, J. Cardwell Lees, CARDIE.